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A REVIEW OF THE TELEGRAPH IN 1888.

FROM information contained in the *Journal Télégraphique* of January 25th, it appears that the year 1888 presents certain features worthy of remark, not only in the development of electrical science, but also with respect to the important events in the history of the telegraph and the telephone.

The number of States which have signified their adherence to the Telegraphic Union amounts to 40. The Argentine Republic will be shortly included among them. During the year two cable companies, the Spanish National and the West African have entered the Union.

It is interesting to notice that in Belgium the postal administration has been separated from the telegraphic, the two services having been hitherto under one direction.

The sixpenny rate on the transatlantic cables has been, as was expected, raised to one shilling per word. The low tariff was only adopted as a temporary measure. It is a matter for congratulation that these companies have not returned to the higher rate existing in 1886.

A tariff per word pure and simple has been adopted by Sweden and Norway, with a minimum message of 10 words. This system is meeting with more general favour.

The result of the lowering of rates brought about by the Berlin conference is satisfactory as regards increase of messages. There appears to be an augmentation of about 20 per cent., divided more or less equally between internal and international correspondence.

Very little addition during the year 1888 has been made to the telegraph system in general, the work executed in the preceding four years having apparently, so far as regards submarine cables, been in advance of actual requirements. In this particular branch, the only additions have been, the cables between Cuba, Hayti, Santo Domingo, Curaçao, and Venezuela; these sections, owing to difficulties raised by other companies with regard to exclusive concessions, have not yet been opened to the public. *The cables between Formosa and the Pescadores Islands; the Java cables connecting up the islands of Bali and Celebes; and an increase of about 340 miles to the Italian Government system of coast cables.

Among the cables either being laid or in course of construction we may mention the triplication of the lines between Java and Australia and the cables which will continue the present West African system from Sao Paulo de Loanda to the Cape of Good Hope.

Of those schemes as yet immature, but which are discussed as likely to be carried out, by far the most important is the proposed Pacific cable between Vancouver and New Zealand. A tariff per word of four shillings is suggested and an annual subvention from the Governments interested, of £75,000, to last 25 years, is required. Canada and the Australasian colonies are energetically pushing the scheme.

Concessions have been granted for the laying of cables to connect the Antilles Company's system, now terminating at La Guayra (Venezuela) with Vizeu (Brazil) *viâ* Paramaribo (Surinam). This scheme would afford another route for communications with South America.

Rumours, not, however, very credible, have been current that the British Government has entered into a contract for the laying of a cable between Halifax and the island of Bermuda. The mythical Azores-West India cable is, we believe, considered by those interested to have been placed on a more solid basis. We understand that of the first section, Portugal-Azores, about half-a-mile has been laid on the Portuguese coast as a temporary measure for saving the concession.

The two Atlantic cables owned by the Western Union Company, which since 1882 had been retained for English traffic exclusively, were during the past year opened to the general telegraphic service.

* This is a mistake. These cables were laid in October, 1887.

With regard to land line extension there is but little to say. We have only to record the construction of a line in Corea between Seoul and Fusan, the opening of telegraphic communication between Selangore and Sungie-Ujong in the Malaccan peninsula, some small extension of lines in the vicinity of Accra, West Coast of Africa, and a few new stations opened to public service in China. On the other hand, Persia has closed to international transit the line *viâ* Bachkale, opened in 1882.

In reviewing the conditions of the enormous telegraphic system spread over the world, it is worthy of remark that so few interruptions have occurred on the more important submarine cables. With the exception of the Brest-St. Pierre cable, laid in 1869, no one of the principal cables has broken down during 1888. Even the minor cables, generally following coast lines, have not suffered interruption to any very considerable extent, and it is remarkable how speedily, in the majority of instances, the repairs have been effected.

In the Gulf of Mexico and the West Indies there have been 8 interruptions, having an average duration of 10 days;

In the Eastern seas there have been 9 interruptions, having an average duration of 11 days;

On the Brazilian coast there have been 8 interruptions, having an average duration of 12 days;

On the East and West Coasts of Africa there have been 7 interruptions, having an average duration of 17 days.

The cables on the West Coast of America, extending from Tehuantepec, in Mexico, to Valparaiso, in Chili, have suffered remarkably few interruptions, certainly not more than two or three.

One of the principal events connected with submarine telegraphy was the coming into effect, in 1888, of the Convention for the Protection of Submarine Cables. Including the British colonies of Australasia, the Convention has been agreed to by 38 states.

Some of the facts connected with the maintenance of certain of our principal landlines are deserving of mention:—

The Siberian line, some 7,000 miles in length, was only interrupted twice—on the first occasion for one day; on the second, for five days.

The Indo-European line, which crosses the whole of Europe and a portion of Asia, certainly not less than 6,200 miles in length, was only interrupted once, and then for two days.

The line which crosses the Andes and unites the Argentine Republic with the Pacific coast, was interrupted once, for a period of 20 days.

Unfortunately such good records cannot be reported of the condition of the lines which connect British India with Saigon. These communications have been interrupted during the past year on no less than 20 occasions, with a total duration of interruption of 160 days, that is, during nearly half the year.

The number of new telegraph offices opened during the year amounted to more than 7,200, including those in the United States. Telephone systems have shown a great increase: North America has more than 750, with nearly 200,000 subscribers. In Europe, Germany takes the lead with 167 systems and 26,000 subscribers; Sweden comes next with about 150 systems and 15,000 subscribers; Great Britain follows with 125 systems and over 20,000 subscribers; then come Switzerland with 71 systems and 8,000 subscribers; Italy with 49 systems and 9,600 subscribers; France with 39 systems and 10,800 subscribers; Russia with 36 systems and 7,600 subscribers. To these figures may be added, for the remaining European countries, about 100 systems with some 25,000 subscribers.

We have not much to say on the subject of improvements in telegraphic apparatus, except to mention that the new Baudot distributor has much increased the value of this already very perfect instrument. It has been very favourably received in Italy, where it is employed on several important lines. As regards telephones, attention has been chiefly paid to improvements in transmitters, while the most varied forms have been developed in microphones, which are rapidly being adapted, with excellent results, in long distance telephony. Among the long lines at work in France, that between Paris and Marseilles, about 560 miles in length, offers a very interesting example. We believe this line to be the longest of its kind in Europe. A problem which occupies the attention of inventors is the question of long distance telephony through submarine cables. In view of the wonderful discoveries made from day to day—the telephone itself is one of them—who can say that the realisation of telephonic correspondence through the Atlantic cables is far distant?

THE good people of the city of culture, otherwise the "Hub of the Universe," who have been resting in fancied security, under the supposition that electricity was universally recognised as the safest known means of artificial illumination, have been unpleasantly awakened by the announcement of the Tariff Committee of the Boston Board of Fire Underwriters, that on account of the increasing number of fires caused by electric lighting apparatus during the past year, it will most likely be deemed necessary to raise the premiums on this class of risk. Should the Underwriters persist in their determination to increase the rate, some injury will be done to the electrical industry, and friction will be sure to arise between the various electric lighting companies and the insurance bodies. The details of these fires are not to hand, but they do not appear, as a rule, to have been of a serious nature, although it is asserted that this freedom from heavy losses was a matter of sheer good fortune. The Underwriters of Boston must be a timid set of men, alike incapable of formulating a set of rules for compulsory use by lighting companies or bearing their losses with equanimity, notwithstanding every installation has been passed and certified by their own inspector.

THE tramp is to the fore again, not the ordinary tramp whom everyone knows and who is simply a nuisance, but the tramp wire which is a constant danger and menace to every town in which it is allowed to remain. No one notices it. If a wire in common use goes wrong there is a complaint and the defect is

remedied. This is not so when a wire becomes a vagrant; it does not pay to remove it, especially if an iron wire. Time elapses, the wire rusts, and at length breaking, trouble ensues, any mischief that may follow being saddled on a possibly perfectly innocent electric lighting system, which up to that time was in thorough working order. No town can be safe under this condition of things which it should be everyone's business to endeavour to abolish.

THE Imperial Continental Gas Association has found it necessary to construct fresh works for the supply of Vienna, as the consumption of gas is rapidly increasing, notwithstanding the vigorous competition experienced from the development of the electric light. This same company supplies electric lighting from its central station, and it would appear from the extension of the gas works that the electric light has not established a superior position to that held by gas in the opinion of the consumers. In the village of Stockerau, near Vienna, the municipality invited tenders both for gas and the electric light; as the tender for the former was for a considerably less sum than for the latter, the contract was given to the gas company. It seems that this decision has not met with the approval of some of the inhabitants, who have erected their own private electric lighting installations. The gas lighting has as yet not been realised, owing to the collapse of a reservoir, although the works have been completed for some time. The estimate for the gas installation amounted to a little over £8,000, and for the electric light to about £9,600. The repairs to the gas plant will cost about £2,000, bringing the total cost higher than that estimated for the electric lighting, a fact which the advocates of the last-mentioned system have availed themselves of as an argument in favour of the method they support.

THE Chief Clerk of the Patent Office in Washington has publicly declared that perpetual motion is an assured fact, and at the present time there are now in the Patent Office machines which have sufficient power to run themselves from now to doomsday. He also makes the statement that "a machine with surplus power for the purpose of running other machinery will come some day, and may come at any time." It can hardly be wondered at that, in view of these opinions, the American newspapers are expressing some anxiety as to the practical management of a department in which the Chief Clerk may possess some control.

WE are glad to see from the general tenour of the article in *Industries* on Mr. Radcliffe Ward's Electric Omnibus, that every encouragement is given to the inventor to go on and persevere. Mr. Ward has met with opposition to his schemes from one of our contemporaries, but it is of a somewhat mild nature and evidently the outcome of a mind not yet sufficiently matured to be entitled to any serious consideration. The enquiry as to how omnibuses are to be expected to turn out successful as worked by electricity when tramcars have been comparative failures, seems to us to be quite beside the mark, for the cost of omnibus locomotion with horse traction is certainly in excess of that on tramlines, and gives even a greater margin for profit under electric propulsion.

In the *Daily Telegraph* of Monday, in the list of events about to take place, we noticed the following:—"February 19th. Electropathic and Zander Institute, 52, Oxford Street, W. The Medical Battery Company, Limited, will hold a Medical and Scientific Conversazione. The chair will be taken by Mr. C. B. Harness, President of the British Association of Medical Electricians." We wonder if Sir William MacCormac has received an invitation to be present? His opinion on the Zander Institute entitles him at least to this courtesy.

TWO years ago the Taunton Electric Light Company possessed one dynamo, now it possesses six. On Monday, at the second annual meeting of the shareholders, a dividend of 6 per cent was recommended, and next year it is confidently expected that this will be increased. A glance at our City columns will show that the plucky efforts of the directors have been highly successful, and everybody will bear out the assertion of Mr. Potter, that the history of this company is unprecedented in the annals of electric lighting in England. May it go on and prosper!

WE think that everybody interested in true progress will feel in a self-congratulatory mood that the work of electrically propelling the trains in the City of London and Southwark Subway has fallen into the hands of Messrs. Mather and Platt. They have certainly the means to carry out this important undertaking in every detail, and nothing will be wanting in the way of scientific advice, the previous success of Dr. Edward Hopkinson in electric traction being a sufficient guarantee in this respect. One great success of the kind will do much to create a general feeling in favour of employing electricity more generally for the propulsion of carriages on short lines.

WE learn upon good authority that Messrs. Crompton & Co., Limited, are about to start two central stations in the heart of the City. This, from some points of view, would seem to be a good set-off against the operations of the London Electric Supply Corporation, and probably those also of the Metropolitan Company. Regret, however, may be felt in some quarters that the firm which has gained its reputation by the manufacture of the necessary plant for electric lighting purposes, rather than by supplying electrical energy, should occupy itself in breaking up fresh ground. The position may, however, have been forced upon Messrs. Crompton as an outlet for the employment of their capital, but in any case we may rest assured that nothing will be left undone to secure success.

MR. A. DU BOIS REYMOND does not apparently think very highly of the chances of alternating current motors becoming practical and commercially useful commodities, at all events in the light of our present knowledge upon this subject. The matter, however, is one which but very few people have investigated, and upon it still fewer care to commit themselves to an expression of opinion. The author of the paper which we published last week had evidently studied his position very carefully, and we doubt whether there are any electricians in this country who will desire to break a lance with him. From America, however, we may perhaps expect a retort from Prof. Elihu Thomson and one or two others.

SIX YEARS' PRACTICAL EXPERIENCE WITH THE EDISON CHEMICAL METER.

By W. J. JENKS.

(*Concluded from page* 120.)

Fig. 9. It is plain that the change due to a rise of current in the meter here illustrated from 0 to full load, or 20 ampères, is 0·0017 volt. As this counter E.M.F. appears in practice as a factor of resistance, its effect is shown in the current resistance curve.

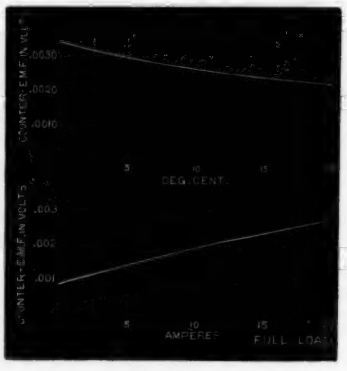


FIG. 9.

It is also clear that the error due to the rise in temperature from 0° to 20° centigrade is 0·0012 volt. This is one of the factors in the temperature resistance curve.

Bottle Resistance and Current.

The two errors, increase of counter E.M.F., and consequent rise in potential difference, and decrease of absolute resistance, and consequent drop in potential

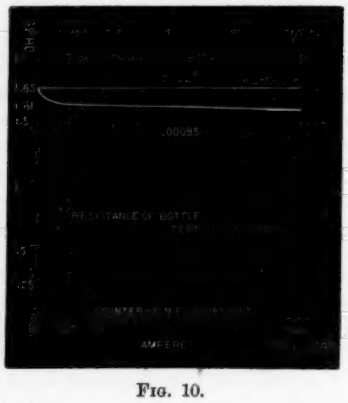


FIG. 10.

difference, jointly resulting from an increase of ampères, about balance each other, forming a beautiful compensation which makes this curve almost a straight line. (Fig. 10.)

Temperature Compensation.

Fig. 11. Considering the bottle resistance by itself, the fall in counter E.M.F., and consequent drop in potential difference with a rise in temperature, adds slightly to the drop in volts attending the fall in resistance. These two factors are together opposed by the influence of the spool, whose copper wire increases so as to make a perfect compensation at 10° and 30° centigrade, with a slight bend in the curve at intermediate points.

Rate of Deposit and Current.

Fig. 12. This curve, the result of the combination of the sources of error shown by the others in detail, is so close an approximation to an absolutely straight line that it is difficult to detect any material departure excepting the slight bend at the minimum load. Into the depth and sharpness of this bend the element of time enters, but after passing this point the curve runs almost absolutely straight to a maximum load.

It is especially noticeable that the curve begins at absolute zero, while with Mr. Edison's early meter of the electric motor type, and others that have followed this principle, the theoretical curve is as shown by the dotted lines.

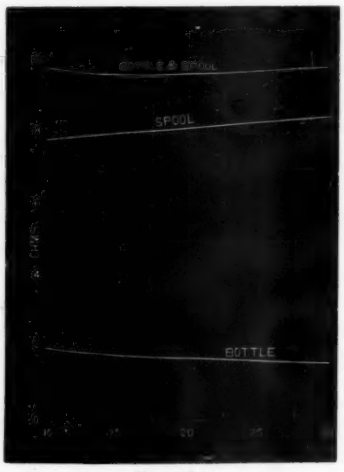


FIG. 11.

No curves deduced, as are the above, from long practical work, have ever, so far as we can learn, been formulated of the performance of any other meter.

It is proper to say in this connection that the percentage of error from these causes is practically constant for all sizes of the Edison meter.

Some months ago a very careful test, covering five months, was made by the engineering department. Six

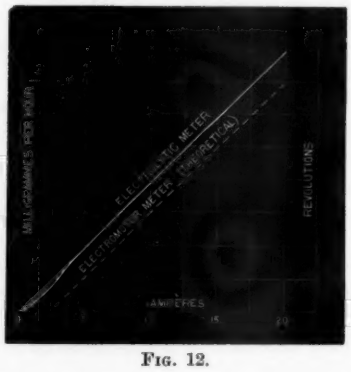


FIG. 12.

Edison meters were connected in series with the meter of the Edison Electric Illuminating Company from the station by which the current is supplied to the offices occupied by the parent company. At the close of this test it was found that all of these meters registered within 1½ per cent. of each other.

An elaborate test was conducted at New Brunswick, N.J., by Mr. W. S. Howell, with seven meters put in series with ten lamps. The readings showed a variation of only one and a half cents in the amount of the bill charged, while four of them were alike to a cent. The advantage of such accuracy is manifest not only to the Illuminating Company, but must also be satisfactory to the most exacting customer. One of our most experienced and successful managers testifies that in the use of about 200 meters he found the poorest record to be very close, and sums up his experience by declaring "that without the meter they would be swamped."

But the only real criterion is that of practical success.

In order to discover what the practical men in the business think of the meter, a circular was recently ad-

dressed to the 26 stations in the country now operating the meter system, asking for their experience and opinion. To this we have, up to this time, received 23 replies; that you may judge of the convictions which they express, I will read the more important queries, and summarise the answers.

Have you used meters from the starting of your station?

Answers—Yes, 17. No, 5.

From your experience what reasons would you quote for a change from the contract to the meter system?

All replies to this question indicate the unanimity of the opinion that the meter is far preferable. Some of the expressions are as follows:

1. "There is no argument about lamp breakage." "It is square dealing on both sides."

2. "They are always superior, even to the best contract."

3. "Less unnecessary burning; income in more fixed ratio to expenses." "Customers are able to regulate their light bills." "An accurate basis instead of guess work, an estimate schedule price." "Life of lamps should be much longer by use of meter, by the stopping of unnecessary burning."

4. "We should take in a great deal more money than we do now."

5. "There are a few exceptional cases where we are getting a little more out of contracts than we would from a meter; but as we run by night only, this difference is made possible. I refer to early closing stores. If we ran by day these would use light by day on contract, while they would rarely do so if the current were measured. I find generally that dwellings on contract are constantly fully illuminated; but the day a meter is put in, they find one lamp generally suffices. I believe our income would be slightly larger if everything were on contract, but our expenses would be out of all proportion. Immediately after taking charge of this station, I looked up the last ten minute record made by outgoing current, dated December 23rd and 24th. It is possibly a little unfair to take a day or night so near Christmas, as more light is used at that time than at any other. The nearest aggregate I could get out of 75 tests in money value was at 1 cent per hour per 10-candle lamp (and the company charged at that time 1¼ cents per hour), and after deducting station and street lighting, $2,868.90, while the income of the company for that month from all sources was about $1,100. Of course, during the winter months, the contract consumer gets more than he pays for, and is reckless in the summer, because he thinks he gets less than he pays for."

"By all means, were I to build and manage a new station, I would start it on a meter basis, and carry it as far as possible."

7. "Our object was to decrease the unpaid consumption and increase the revenue."

8. "We believe from our experience we can supply more on meters with the same power and get a better return from current used."

9. "The contract gives a regular income to the company throughout the year, nevertheless in a majority of cases it is a system of robbery; electricity should be sold like merchandise—by measurement."

10. "The principal reason for a change to a meter system was the impossibility of making contracts which were fair to the company. Customers will burn more light than they contract for, and though under a contract system it may be easier to collect bills, at the same time the income per lamp hour will not average much more than half that of the meter system."

11. "It prevents people from consuming an excess of current, thus unnecessarily overloading the station."

12. "Under a contract consumers abuse the use of the light, which abuse, while doing the customer no benefit (the light not being necessarily used), increases the cost of operating and lamp breakage to the company very largely. In other words, you cannot trust customers to cut their own cloth."

13. "More satisfactory to the consumer if he is economical."

14. "Maximum revenue for maximum power."

15. "Consumers can gauge the quantity of light for which they pay to suit the business requirements.

Do you keep meters on contract installations for your own information? Some of the replies are as follows:—

"We have and find a contract consumer is using about double what he pays for. Some customers have left us on this account but almost always return."

"Yes; on all motors also."

"We run them in this way at intervals for our own satisfaction."

One of the largest of the stations keeps a meter on each contract motor.

Have you evidence of any serious error aside from accidents? If so, please state explicitly what it is.

Eight stations, embracing the large ones at New Orleans, Rochester, La Crosse, Cincinnati and New York, reply to this question.—"*No.*"

One of the most experienced station managers makes this reply:—

"We have none. In my judgment the greatest amount of complaints come from places where a notable lack of care is shown in properly preparing plates, weighing and handling; also where leaks and grounds are most numerous. The meter has in past years located many faults for me."

Is the feeling of your customers generally one of confidence in the accuracy of the Edison meter?

Most of the stations reply without other remark than emphatically, "Yes." Some of the answers are worthy of being quoted literally.

"In some cases our customers keep count of the hours. All such customers say the meters are correct."

"Remarkably few objections by consumers to the results obtained."

"The general feeling is one of confidence."

"The confidence is fully as great as in gas meters; we have no difficulties on this account."

"Complaints are very few from consumers."

"The meter to our customers is a blank. While we can persuade them that the meter is correct if properly manipulated it becomes a matter of confidence in the meter man."

"One month ago one of my customers began keeping a record of the hours his lamps were burning. When his bill was presented it was four cents in his favour; so it is with a great many. The meter has given us good results."

"This question is rather a difficult one to answer. I have no doubt that the majority of our customers if they were asked the question would say that they did not believe in a meter. This is not due in a great many cases to any inaccuracy they have ever discovered, but merely to the general idea that meters are not worth anything, judged by the gas and water meter standards. We have had a number of customers test our meters, and in addition to this have given us strong letters of recommendation, and I have never seen the test where we had to recede from our position that the meter was correct."

"They have as much confidence in the Edison meter as in the gas meter, and probably a little more."

"Those consumers who keep a careful lamp account for a few months have faith in the meter."

From the results of your experience with the meter system do you feel that you can endorse our recommendation to new companies that they adopt it as the most satisfactory method of serving the public?

"Yes, I have already advised several new companies to adopt it. Contracts are bad—they soon get the best of you."

"We believe that it is the only way to sell light. We only have contracts to satisfy certain customers."

"Yes, where practicable; which, however, is not always the case in starting stations in small towns."

"I do not believe in the contract basis at all. I feel that the meter is a good thing, and particularly because my Jew customers and other economical consumers never raise any questions, and we never have any trouble with them."

"Yes, most decidedly for large stations. The desirability of putting in a meter system depends on the size of the plant. I do not consider that any plant of over 500 lights can afford to get along without it."

"Yes, but would offer contracts as well. Give them what they want, and if one does not prove satisfactory give them something else."

The Edison Electric Illuminating Company of New York,
16 and 18, Broad Street.

Spencer Trash, president.
Jonn I. Beggs, vice-president and general manager.
J. B. Skehan, secretary and treasurer.

New York, *December 27th*, 1887.

E. H. Johnson, Esq.,
President Edison Electric Light Company :—

Dear Sir,—Replying to your enquiry as to the accuracy and degree of reliance placed upon the Edison meter in the commercial transactions between this company and its customers, it affords me pleasure to state that our experience has established confidence in the meter, not only on our part, but also on the part of our customers, in consideration of which I offer you the following facts :—

The Pearl Street station was started September 4th, 1882, and, with the exception of but two hours during the first year, has continued uninterruptedly to date.

The station is at present supplying current for 15,000 incandescent lamps and 150 H.P. of Sprague electric motor to 647 customers through a like number of meters.

Our bills are paid cheerfully with but an occasional exception, in which instances a verification of the meter is had, and the customer thereby thoroughly convinced of its accuracy.

Repeated tests of the meter, comparative and otherwise, made by ourselves, show a maximum variation of not greater than 2 per cent., and a variation from accuracy of not more than 1 per cent. These tests, combined with the practical results of five years actual use of several hundred meters, have demonstrated conclusively to the company and its customers the efficacy of the apparatus for the purpose intended.

Yours truly,

THE EDISON ELECTRIC ILLUMINATING COMPANY OF NEW YORK,
By JOHN I. BEGGS,
Vice-president and general manager.

The following, it is hardly necessary to say, was penned in the bracing air of the Rocky Mountains, and has the ring of Western enterprise.

I can endorse the meter for two reasons. It is the friend of the poor man as well as the company, for the following reasons :—It gets action on the horny-handed son of toil this way. Our contract price for lighting houses for five lights is $4.25 per month or $51 a year. Now there are lots of customers who cannot afford to pay that but can afford to have five lights installed and use the meter, which will probably not average over $2.50 per month or $30 for the year. At the same time if they should contract for $4.25 per month and run, some till 12 o'clock, for a month, they would consume $13.50 per month (if measured by the meter), but we would only get $4.25. If all did this our load would overrun our capacity, but, thanks to the little box, she holds her down. It produces the same effect with business houses. Our contract price with this class is $1.50 per month (all my figures are based on 16-candle lamps). Houses having 25 lights would be $37.50 monthly, by meter, we would realise $29.10 average for year, arc lighting being 6 till 9. You see we get $29.10 for 3 hours' light, while with contract they could burn till 12 for $37.50 or 6 hours' light. The meter holds the load down for families when they use only one or two lights a night, but if contracted they would "turn her loose Murphy," in order to play even. It is our experience that the people always manifest a desire to play even with a light company, if possible, and if they can't get action one way they will another.

Our meters here are a great deal of labour owing to the number we have in use, but still we can't get along without them and really think they are reliable if conditions are equal. My tests here have been very flattering, have had them within one-tenth of one per cent. of bill, and the highest out was 2¼ths per cent. high.

For customers using a large amount of light it is cheaper for them to contract here, but for small customers the meter is the correct thing and with us produces satisfaction and good results among the customers. In the summer bills are small but the winter months balance them and run higher; when expenses increase so do the meter bills, but with contracts it would be the same.

The 23 reports referred to represent the following aggregates and averages :—

Total number of lamps of all powers in 23 stations	117,501
„ „ „ „ on meters	87,856
„ „ „ „ on contracts	29,305
„ „ „ motors	350
„ horse-power of motors	1,000
„ number of meters of all capacities	5,187
„ „ „ two-wire meters	4,531
„ „ „ three-wire meters	660
Average number of lamps per station, meters and contracts	5,109
„ „ „ „ on meters, 23 stations	3,820
„ „ „ „ on contracts, 20 stations	1,465
„ horse-power of motors	3
„ number of meters per station	226
„ „ „ lamps per meter ... about	17
Total cost of operation, 16 systems	$16,235.00
Average annual cost of operation per meter ...	4.03
„ „ „ „ „ lamp ...	0.22

One of the reasons for this confidence is found in the fact that of the 18 stations equipped with meters, for the measurement of 75 per cent. of their entire lamp capacity, and relying upon these meters for the amounts of their bills to consumers, four are earning upwards of 15 per cent. on their capital; three others between 10 and 15 per cent.; three others between 8 and 10 per cent., and seven more upwards of 5 per cent. Others have been operating for too short a time to yield definite results.

The following extract from a letter from Mr. J. W. Lieb, Milan, Italy, written under date of November 2nd, 1888, demonstrates clearly how satisfactory the action of the meter may be made, even when the urgent cares of a rapidly growing business forbid the one engineer of the station, who is thoroughly informed on this subject, from giving the details of its operation any considerable personal attention. Mr. Lieb has laboured under the additional disadvantage of being at a great distance from the birthplace of the system, and the scenes of its widest usefulness.

We have at present actually in use in Milan some 360 meters of various types (all Edison meters), the smallest for 350 ampère-hours per month, and the largest 30,000 ampère-hours, with a respective maximum capacity from 4 to 400 ampères.

All the current from the mains is paid for by the ampère-hour, according to the sliding scale of charges herein enclosed.

The temperature to which the meters are exposed varies between 5° C. and 35° C. We have never had occasion to apply thermostats to the meters. The results of our experiments, and our general experience with the meter, have given us confidence that if carefully treated, its indications are fairly reliable, the maximum error (low reading) occurring with light loads.

While we have some consumers whose consumption of current is comparatively uniform throughout the year, the majority (among whom many apartments) consume little or no current during the summer months, some consumers closing their apartments, and making the meters inaccessible for four or five months.

Our consumers are, as a rule, very close, a number keeping careful account of their lamp hours (ampère-hours) from month to month, the larger ones having clerks specially delegated for that purpose.

This fact, coupled with the unfavourable conditions of supply above noted, makes it necessary to apply all precautions to avoid contestations, and I am glad to say we have been fairly successful in meeting the difficulties.

We keep a careful half-hourly register of the indications of the main station ammeters and the feeder ammeters, and find them to agree with each other, and their sums with the ampère-hours given monthly by the meters within a small percentage of error which we have observed is a maximum during the summer months, the sum of the meter indications being slightly low.

Such abuses of the contract system, as are shown by these expressions, are so manifest to many contract stations from which we have asked for no letters, that some of them are already changing to a meter basis, and it is evidently only a matter of a short time when others will be compelled to.

At every meeting of the association of Edison illuminating companies, there has been a full and impartial discussion of the relative merits of the two methods. The result may be briefly and forcibly summed up in the following, unanimously passed at the meeting of the association held at Chicago, Illinois, February 9th, 1888 :

"Resolved—That after a full discussion of the relative merits of the meter and contract systems in the numerous meetings of this association, that it is the sense of the association that the Edison meter is accurate, that the system is not too expensive for stations above 1,000 lights, and that the best financial results are invariably secured in a station selling by meter."

Recent Improvements.

Nearly a year ago a series of exhaustive tests was undertaken at the laboratory of Mr. Edison, to determine whether, in the light of years of experience since

the initial experiments upon which the first methods were based, advantageous changes can be made.

The first result of these tests was the perfection of the general details of the three-wire meter, then being offered to the Edison stations. The present form of connecting spring clip was at once introduced. A diagonal arrangement of terminals, making it easy to connect from either side or from below, followed after. Then the production of pure chemicals by the Edison laboratory, and the elimination of the error due to oxidation, already referred to, by proper treatment of the solution.

At a meeting of the Standardising Bureau, held December 17th, 1888, it was voted to authorise the discontinuance of the two largest sizes of plates (40 and 80 ampères), and the use in their places of the 20 ampère plate, with a proper change in the compensating spool in each case. It was found perfectly feasible to measure the shunt resistances and weigh the plates more accurately than heretofore, thereby effecting a substantial saving in cost and care of large plates. As an illustration, a 200-light plate only needs to be weighed to one-sixteenth of the exactness in units, of what is necessary in a 12-light plate, to secure the same percentage of accuracy.

It was also decided to authorise the use of one bottle in place of two for the three smaller capacities, which, as appears by the average figures given, constitute a large majority of the total number in use. This will probably be followed by a change in all sizes as soon as confidence in the feasibility of this plan becomes general. One bottle meters for two-wire uses and two bottle meters for three-wire will therefore be immediately produced.

These important changes, which it will be observed simply follow as a natural result of the confidence established by experience, will probably be supplemented by others, none of which will, however, modify any essential features of practice, but simply apply processes which add nothing to the expense, but tend to eliminate the already small sources of error. Among those indicated as likely to be recommended are a reduction in the size and change in the form of the bottles and method of closing; a slight change in the specific gravity of the solution; and a modification of the treatment of the plates by which the active surfaces shall be limited to those placed directly opposite each other in the cell.

These minor changes will aid still farther towards the result which Mr. A. E. Kennelly (under whose personal supervision, on behalf of Mr. Edison, the present tests are being made) predicted in a recent lecture would be realised—namely, that "the Edison electrolytic meter will in the future be recognised as the simplest and most accurate apparatus of its kind in commercial use."

An interesting application of this Edison meter principle has been made in England, and is described as follows in the *Electrician* article already quoted, relative to a multiple series installation at Brighton :—

"The objections to the electrolytic method are absent when it is employed in connection with a constant current distribution. In the first place, we have now to measure the 'volt-hours' across the terminals of the house connections, so that the meter is a shunt to the whole installation. By placing a high resistance in circuit with the meter, in order to reduce the current in the shunt circuit, no error is introduced. Secondly, by integrating the E.M.F., and assuming constant current, we are introducing no non-existent factor; in fact, the current at Brighton is actually maintained constant within 1 per cent.

This suggests interesting possibilities in measurement of energy supplied to customers of series-circuit systems.

I have not taken your time this evening to prove by aggregation of testimony that a meter basis is the proper principle, or that the electrical fraternity needs it and should be educated to its use. This is self-evident. My aim is to show by the incontestable logic of facts that it is entirely practical and economical to accomplish all that is required by a method which is widely applied, and to emphasize by varied, but singularly harmonious quotations from the experience of men who are! by its help earning dividends, the result of "Six Years' Practical Experience with the Edison Chemical Meter," which is the topic of my paper.

KENSINGTON ELECTRIC LIGHTING.

THE CONTROVERSY CLOSED AND A SCHEME ADOPTED.

THE protracted controversy respecting the subject of electric lighting in Kensington has at length been brought to a close, and important conclusions have been arrived at. No proceedings so thorough or so wide in their bearing have taken place elsewhere on the question of admitting or excluding the electric light, and although at the outset there was a good deal of bungling and (perhaps inevitably and appropriately) groping about in the dark, the results which the special committee of the vestry have reached, will prove of great value in guiding other authorities upon a like problem. The dogged persistency with which the Kensington Vestry have latterly kept this matter in the front, and insisted upon settling it, and the anxiety shown by a number of supply companies to obtain concessions in the "Old Court suburb," are of good augury for electric lighting, and an example worthy of emulation in other directions. As we have explained in previous articles, the vestry appointed a special committee to consider and report upon certain applications for leave to supply the electric light to the parish. This happened rather a long time ago, but nothing came of it till last November, when the committee hurriedly concocted and presented a report. That document was almost summarily rejected, and the committee were "sent down" to produce something better. The vestry were determined to have a clear, complete case before them, and the committee, taking the hint, tried again. A second report was almost equally a failure, and the committee were strengthened by the appointment of additional members. The outcome is a report which appears to leave nothing to be desired, in point of fulness at all events. Covering more than 20 pages of closely printed matter, as it does, it may properly be described as "lengthy and exhaustive."

Originally three electric light companies, the Notting Hill, the Kensington Court, and the House-to-House Companies, intimated their intention to apply for licences; subsequently these three, and also the London, the Metropolitan, and the Chelsea Supply Companies gave notice that they would apply for provisional orders. One of the defects of the committee's first report was the absence of information as to the financial position of these companies, and their ability to carry out their proposals. In the report presented a week ago financial particulars were given. For instance:—House-to-House Company, proposed capital, £100,000; subscribed by *bona fide* shareholders, £41,035. Kensington and Knightsbridge (formerly Kensington Court) Company, proposed capital £250,000, subscribed to January 10th, £35,475. Notting Hill Company, proposed capital, £100,000—"public not yet applied to for subscription." Metropolitan Supply Company, proposed capital, £500,000; "all subscribed." Chelsea Company, capital authorised, £100,500, subscribed £34,000, paid up, £30,470. London Supply Corporation, proposed capital, £1,250,000 "at present;" subscribed, £555,000, paid up, £409,800. These details are supplemented by statements as to various steps the companies were prepared to take to satisfy the Vestry. Having this information before them, the committee came to the conclusion that "there was no objection to any company named, on the score of inability to carry on work, or of its *bona fide* character, and had come to the conclusion that there was no sufficient reason for excluding any of them from Kensington on account of

pecuniary status or probable incapacity to carry out undertaking. Contrasting the relative advantages of a system of licences and one of provisional orders, the committee recommended the vestry to refuse (with certain exceptions) consent to all licences."

During the warm debates upon the earlier reports a great deal was said, *pro* and *con*, upon the question of granting monopolies to individual companies in the different districts as they had been mapped out by the committee. To this point the committee naturally gave further attention, and they reported that they had been particularly occupied in the consideration how best to secure to the consumer the advantage of the electric light, supplied with regularity and safety, at a reasonable price; and also, to the ratepayers and inhabitant, the least interference with the public streets—in other words, to combine the benefits of competition with those of a well-regulated monopoly. Under the Electric Lighting Act, 1888, no legal monopoly is given to any company by the granting to it alone in the first instance, by provisional order, the right of lighting any part of the parish; and considering the right the Vestry would have, if circumstances should require it, to obtain themselves, or to consent to other companies obtaining, provisional orders to light the same districts, the committee thought it better in the first instance to assign a given portion of the parish to only one company. By this means each company would know that its immunity from direct competition in its own district would depend on its good conduct and the reasonable nature of its service and charges, and would therefore, in the opinion of the committee, have sufficient inducement to carry on its undertaking efficiently and economically; and thereby the parish would get the advantage of a potential competition. To further secure this object, the committee suggested a certain modification, by the Board of Trade, of each provisional order, offering a still more powerful inducement to efficiency and low charges. Upon the considerations here set forth the committee recommended: (*a*) That in the first instance only one company have any portion of the parish conceded to it by provisional order for lighting purposes. (*b*) That the Board of Trade be requested to arrange for an extended area of supply being included in each provisional order, subject to such conditions as are above suggested. (*c*) That such last mentioned area should in each case include all that portion of the parish applied for by each company, but which is not comprised in the area to be assigned to such company in the first instance. Assuming that the Vestry adopted the one-company one-district suggestion, the committee further recommended that each of the six companies should have allotted to it a district, as shown on a map, and as delimited in the report.

Passing to various other considerations, the committee expressed the opinion that provisions for safety might be left to the Board of Trade, "which body possesses the necessary powers;" that no company should be at liberty to carry wires otherwise than underground, and that all wires previously placed overhead should be removed. Further recommendations were made with respect to the prevention of smoke and other nuisances from generating stations, the committee in particular urging that no engines of a non-condensing character be constructed, and that the best Welsh or other smokeless coal shall always be used in the furnaces. They also asked that details with reference to the system of charging might for the present be left to them, with a view to obtaining the lowest scale of maximum charges from all the companies, with a revision of charges at the end of a stated period, in order to secure an early reduction in price to the consumer, whenever practicable. With regard to the purchase of undertakings, the committee recommended that they should be authorised to obtain from each company consent to purchase by the vestry after the expiration of 21 years, and at subsequent periods of seven years. Finally, with a view of bringing the electric light into early use, the committee recommended the vestry to consent to the granting by the Board of Trade, to each of the companies named, of a licence to supply electricity within the next few months, such licence to be superseded by the Provisional Order when confirmed by Parliament, or to expire in a year or 18 months from the date of the licence. This business-like report having been formally submitted to the full vestry, and its adoption moved by Mr. Jordan, the chairman of the committee, a very unusual, but highly interesting course of procedure was pursued. On previous occasions only vestrymen had been permitted to debate the subject, but in this instance an expression of views by representatives of the several companies concerned was invited, each one being accorded ten minutes for his speech.

The first speaker promptly sounded a note of opposition on behalf of the Kensington and Knightsbridge Company. Claiming credit for that company as the first to establish the practicability of the electric light in the parish, and at considerable expense, he objected to the recommendation as to the area to be allotted to that company. Areas had previously been submitted, he observed, to the different companies, and they having practically agreed, considered the matter settled. But now it seemed there was to be a change in the areas, and that alteration his company would not accept "if they could help it." His next point was as to the proposed prohibition of non-condensing engines. This, he predicted, would render electric lighting stations impracticable, because it would compel them to take water to an extent and at a cost which would simply be prohibitive. He also objected to the exclusion of all but Welsh coal, urging that with properly-constructed furnaces other coal could be used without the emission of smoke; and, finally, he advocated the principle of not letting a second company into a given area, unless the first one was not doing the work efficiently. Mr. Walter, who spoke for the Metropolitan Supply Company, devoted himself less to criticising the report than to extolling the enterprise and the resources of his company. They had, he explained, a large station in operation in Whitehall, another nearly completed in Sardinia Street, another commenced in the Savoy, and, altogether, arrangements made for six stations. All these were to be connected, so that in the event of a breakage of current from one station, all the others would give assistance, and thus there would be no inconvenience. By the same system they could supply the light at different places, and at varying times, and in case of emergency they could throw the whole energy of all the stations in one direction. "Under these circumstances," he added, "they were prepared to take up whatever district the vestry thought fit to allot to them." Nothing could well be more accommodating and gratifying than this attitude; but the chairman of the Notting Hill Company was equally friendly and obliging. He had no objection to the area allotted to his company, although it was not quite what they would have selected. It was true they had practically no capital, for the company had been got up by local gentlemen without a view to profit, and really to light their own houses and their neighbours' houses; but they were promoting a Bill to give them the necessary powers, and if the decision of the vestry was in their favour, "they were prepared to start works at once." More than that, the whole of the capital would be devoted absolutely to the work of the company.

Following the pleasant lead thus given, the remaining representatives overwhelmed the committee and the vestry with gratitude and compliments. General Webber, on behalf of the Chelsea Company, was willing to agree to a sliding scale arrangement (if asked), with a view to reducing the price of the supply, and was also prepared at the end of 21 years or 42 years to disconnect the system from the works, and connect with another, or to supply a generating station on terms to be agreed upon. He admitted that the company viewed the area allotted to them in Kensington with a certain amount of regret, but they did not wish to set themselves up against the wishes of the vestry or the committee. Indeed, they wished to express their extreme satisfaction with the manner in which they had always

been treated. The London Supply Company had no spokesman, but Mr. Hammond was present on the part of the House-to-House Company. He was so pleased with the committee and the report, that he was reluctant to take up even the time allowed him; but he felt bound to make public announcement of his satisfaction. There was only one point in the report—and that a technical one—to which he objected. That was as to the embargo upon non-condensing engines, which involved this consideration: The company he represented had already put down works in the parish, with engines of a non-condensing character, and they should feel very uncomfortable if they were told by the Vestry or the Board of Trade to put dynamite under them, blow them up, and put others in their place. Water in their case was a very expensive luxury; they were not next the river or a lake, and had not even a well upon the premises, and they had to be very chary of the water consumed. He therefore asked the Vestry not to be too hard upon them in this matter of detail. Upon the question of price, he asked the Vestry to give the companies a little rope until they saw whether they could really make money or not. It had been suggested that they should have seven years, and that then it should be laid down what was a fair price; and upon this he would say, Don't fix a maximum dividend now. At present the electric light had a very short past; but at the end of seven years it would have a past which might enable them to say what would be a fair price. The spirit of the committee's report really was to encourage a new industry. Let us begin, they said, by seeing what these six companies can do, and at the end of seven years give them more extended powers if they prove worthy of them. We won't bother about systems, they may come and they may go, but the electric light will go on for ever; but our object is not to be bound by any system. But, in order to enable the companies to get to work, they said, by all means let us at once have the district the committee has mapped out. His company had works at Brompton Station, with engines of 600 horse-power waiting to drive electricity through the district, and what they asked was, give us something to do, let us get to work. Personally, he stood entirely by the report of the committee, and believed in every word of it except that little "non" before condensing, and he asked the Vestry to let them have a decision at the earliest possible moment.

After all this affability and passing of compliments it was hardly likely there would be any further difficulty, and the proposal to forbid non-condensing engines was taken out of the report and referred back to the committee for further consideration. The rest of the report was adopted unanimously.

MAGNETISM BY ELECTRIC DISCHARGES.

THE experiments of Prof. Oliver Lodge on Leyden jar discharges, and the discussion of the relation of these experiments to lightning rods, at the late meeting of the British Association, writes Prof. H. S. Carhart in the *Western Electrician*, have drawn attention anew to the lightning rod question. The remarkable experiments of Prof. Lodge are explained by self-induction, arising largely from the oscillatory character of the discharge. Experiment leaves no doubt that a Leyden jar discharge is often and generally oscillatory. If lightning discharges are also oscillatory, then the conclusions derived from a study of Leyden jar discharges may fairly be applied to them.

Objection has been made to the inferences drawn from laboratory experiments, on the ground that it is not known that lightning is oscillatory; in fact, that the magnetisation of needles by lightning goes to show that it is not oscillatory—swinging back and forth like a mass of water in a long trough. Precisely such currents—alternating and slowly decreasing in intensity—have been found to effect complete demagnetisation.

It is known, however, that magnetic effects follow from the flow of an oscillatory discharge round a steel needle. I have examined many such with respect to the penetration of the magnetism and its lateral distribution. In many cases at least, and always under certain circumstances, a thin external shell is magnetised in an inverse sense to the deeper lying layers of the magnet. This outer portion may have its magnetism reversed without affecting the inner portions, and the resulting magnetic strength is equal to the difference due to the magnetism of opposite signs on the same end of the magnet. This peculiar distribution of magnetism I have ascertained by removing with acid successive portions from the outside of small rods magnetised by electric discharges, and determining at each step the weight and strength of pole or magnetic moment of the magnet.

The process of immersion in acid, cleaning and drying, weighing and determining magnetic moment, was continued till scarcely a trace of magnetism remained. The results can be exhibited most graphically by plotting magnetic moments as ordinates, and decreasing weights as abscissæ. Fig. 2 exhibits the results with a magnet 6 centimetres long, 1·8 millimetres in diameter, and weighing 1·21 grams. The unit of weight taken in plotting the curve is 50 mgs. The magnetic moments are quantities proportional to the deflections of the magnetometer. It will be seen that the magnetic moment at first increased to a maximum as the external shell is removed, and then decreases nearly with the weight. This demonstrates

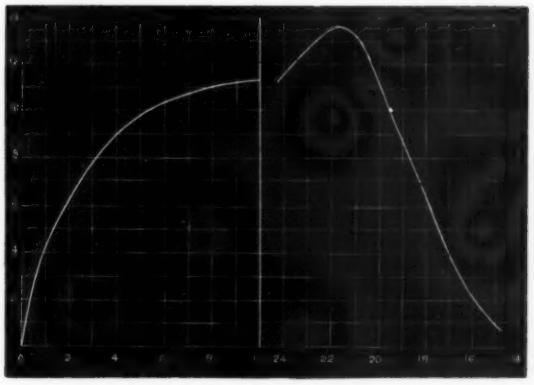


FIG. 1.—DISCHARGES FIG. 2.—DECREASING WEIGHTS

the reversal of magnetism superficially, while the deeper lying portions remain untouched; and this reversal itself is evidence of an oscillation in the discharge. The reversed magnetism is usually extended to about one-third the thickness of the magnetised shell after 10 successive discharges of the Leyden jar through a circuit, the self-induction of which was chiefly due to the magnetising helix of 20 turns of wire insulated with gutta-percha. The inner portion or core of the magnet was always found to be free from magnetism. Occasionally a slight reversal was found at the inner boundary of the magnetised portion of the rod.

In all cases the magnetic moment increases with successive discharges up to about ten. Beyond that the increase, if any, is very small. Fig. 1 shows the relation of magnetic moment to successive discharges through the magnetising spiral. The two figures refer to the same magnet.

An oscillatory discharge is then capable of magnetising steel, and lightning may still be oscillatory, and produce magnetic effects. There are perhaps two explanations—at least two suggestions—which may explain the magnetic effects produced by electric oscillations.

In the first place the mathematical theory, based on self-induction, shows that the maximum values of the intensity of the discharge decrease in geometrical progression, while the alternating currents employed to effect demagnetisation decrease in something like

arithmetical progression. It is not difficult to see that while the latter annul magnetism the former may not.

Again Kirchoff has shown that under certain conditions the time of one of the electric oscillations is much greater than the others. It is not unreasonable to suppose that the electro-magnetic effect of this oscillation of long period may be far greater than the others. It is known that time is required to magnetise iron and steel, and fig. 1 shows that the repetition of electro-magnetic impulses increases the total permanent magnetism.

We conclude, then, that oscillatory discharges do magnetise steel, generally, though not always, in opposite directions at different depths; and that the known differences between such discharges and alternating currents are sufficient to account for the difference in effect.

REVIEWS.

The Telephone. By W. H. PREECE, F.R.S., and JULIUS MAIER, Ph.D. London: Whittaker & Co., 2, White Hart Street, Paternoster Square.

THIS book, which forms one of the "Specialist" series, is, it is perhaps unnecessary to say, the most comprehensive of the kind yet written. Both the authors are in positions which have enabled them to obtain and give information on every branch of the subject, and that they have performed the task they set themselves to in a satisfactory manner, will, we think, be generally admitted. The book is not a complete history of telephony, since the actual number of telephones and telephonic apparatus which have been devised is legion, if we can judge from the hundreds—we might almost say thousands—of patents which have been taken out in this country, in America, and on the Continent. The vast majority of these patents are practically waste paper, and are merely examples of perverted ingenuity; a few, very few, have returned the inventors the value of the patent fees. From the vast mass of ingenuity the authors of "The Telephone" have had to select what has been found to be practically useful, and, on the whole, we think they have exercised considerable discretion. Several systems in practical use, however, we find omitted; thus, we have nothing whatever said about the apparatus of Prof. Sylvanus Thompson, nor of Mr. Campbell Swinton, though both these gentlemen have devised telephones which are well known and are in actual use. The first two chapters of the book briefly deal with "Sound and Speech" and "Induction," and are more introductory than anything else, as no elaborate theoretical considerations are entered into. The third chapter, on "The Bell Telephone," practically commences the subject; this chapter is, however, a short one. We next have "Carbon Transmitters," in which the first Edison transmitter and the Hughes microphone are described. The theories of the actions of the transmitters and receivers are but lightly touched upon, the authors merely giving the opinions of a few theorists, and not expressing any definite opinions themselves. Descriptions then follow of numerous types of receivers and transmitters taken from various sources—in fact, the "scissors and paste" method of compilation is here carried out to the full extent; the authors, however, in all cases give the source from whence the descriptions are taken. One is struck, however, with the fact that German publications figure very largely as the sources of inspiration, to the exclusion of the English and American. The chapter on the "Comparative Efficiency of Transmitters" is particularly interesting, the results of experiments with induction coils of various windings being given; there is, we think, much to be learnt in this direction. The descriptions of auxiliary apparatus, *i.e.*, "switch boards," "call apparatus," &c., practically form the bulk of the work, and it is here that the book differs materially from all others of the kind previously published; in one or two cases the descriptions are not as clear as desirable, the illustrations apparently not belonging to the text. We notice that no mention is made of any systems of direct working, *i.e.*, working without induction coils; as a large portion of the Paris telephonic network is manipulated on this principle the omission is much to be regretted. It is, however, an easy matter to pick holes in any new book; mistakes due to inadvertence are by no means uncommon and should not be too severely dealt with. There can be no doubt, as we said at first, that Messrs. Preece and Maier's book is the most comprehensive of the kind, and it is certain to take its place as the standard work on the subject.

Traité de Télégraphie Sousmarine. By E. WUNSCHENDORFF. Paris: Baudry et Compagnie, Libraire Polytechnique, 15, Rue des Saintes Pères.

Many of our readers will have, no doubt, followed the course of the treatise above mentioned during its appearance in the columns of *La Lumière Electrique*. The work has now been published in one volume.

The compilation of such a mass of material reflects great credit on the industry and perseverance of M. Wünschendorff, for nearly every point connected with submarine telegraphy has been touched upon. A list of the chapters will perhaps give the best idea of the ambitious nature of the work. The book is divided into five principal divisions, the first part containing one chapter, being "Historical;" the second part, entitled "The composition and manufacture of submarine cables," is divided into five chapters, viz., The conductor, The insulating covering, Outer protection, Various cables, and Jointing; the third part, "The laying and repairing of submarine cables," contains five chapters, namely, Machinery, Various apparatus, Sounding and submarine exploration, Laying of submarine cables, and The repair of submarine cables; the fourth part, entitled "Electrical tests on submarine cables," contains four chapters, treating of Measuring instruments, electrical tests on batteries and galvanometers, Electrical tests on submarine cables, and Localisation of faults; the fifth part, "The working of submarine cables," has two chapters dealing with the Theory of the transmission of signals through submarine cables, and Transmitting instruments.

To a numerous and constantly-increasing class of readers, the work will prove of great service, combining as it does so many of the features connected with submarine telegraphy, and while pointing out, as is the duty of an impartial critic, those particulars in which the work fails, it is no less a duty to state that, in many respects, the volume before us supplies a very long felt want.

Our readers will readily understand that we have neither space nor time for a complete analysis of the contents of such a portentous volume; and indeed this unwieldiness in size detracts considerably from the pleasure one might otherwise feel in its perusal; we must confine ourselves to a few brief remarks on the general character of the work.

We cannot say that the work contains anything original or even novel, but the volume has certainly the merit of uniting under one cover information collected from many sources, nearly every work and paper on the subject of submarine telegraphy having been consulted. As a matter of fact, M. Wünschendorff has taken to heart the maxim that "imitation is the sincerest flattery," for among the sins of commission we notice that several formulæ have been copied so *faithfully, that even their errors are preserved.* We of course refer to several of the formulæ which have been copied in their entirety from "Clark and Sabine."

We are far from desiring to appear hypercritical, but we think that the work, taken as a whole, is by no means of an even standard. In some portions the most trivial matters are treated with the minutest detail, while, on the other hand, many questions of the greatest import are either completely ignored, or but very lightly touched on. There are many mistakes, some of but slight consequence, others of more moment, but it would be only fair to admit the difficulty of

altogether avoiding some few errors of commission or omission in a work of this size and of so wide a scope. It would almost seem that the author has attempted too much, but it must be conceded that M. Wünschendorff has succeeded beyond what one might expect from the few opportunities of practical acquaintance with the subject which have come within his sphere of labour.

To the historical portion of the work more care has been manifested than towards any other, and to the general reader this, together with that part devoted to sounding and submarine research, will assuredly prove the most interesting. The engineer, however, will certainly wonder that among the apparatus described in the chapter on sounding no mention is made of Sigsbee's sounding machine, which beyond question is far ahead, in construction and application, of any other method. The author is incorrect as to the greatest depth in which soundings have been made; according to him 3,950 is the deepest, but there are recorded soundings of 4,561 fathoms found by the *Blake* to the north of the Island of Puerto Rico, 4,575 fathoms by the *Challenger* to the eastward of the Phillipine Islands, and 4,655 fathoms by the *Tuscarora* off the coast of Japan.

M. Wünschendorff renders just credit to submarine telegraphy for having enormously increased our knowledge of the physical conditions present in ocean depths, and for having given additional stimulus to submarine research. As a matter of fact, in many expeditions cable ships have carried naturalists and chemists duly provided with the necessary apparatus and laboratories for the purpose of scientific investigation. M. Wünschendorff's statement that in depths of over 1,000 fathoms insects are found which destroy the hemp in a cable is far too general. No doubt it is accurate enough so far as regards the Mediterranean, where the water at considerable depths is at a much higher temperature than elsewhere. Temperature, indeed, has everything to do with insect life, and it has been found that on those coasts where a comparatively cold current is met with, submarine insects are, even in the shallow water, either altogether absent, or very rare.

On turning to the chapters upon the manufacture of submarine cables we do not quite follow the author in his remarks upon the inadvisability of testing the core under pressure, although it is true that certain kinds of faults may be temporarily concealed by the pressure. Messrs. Siemens could have probably furnished him with some information on this point; the system adopted by them is not mentioned.

The figure given as the average conductivity of copper used in submarine cables of to-day is put at 90 to 95 per cent.; we should have placed this figure at 96 per cent. and upwards.

The gutta-percha covering machines, sketches and details of which are given, do not appear to be of quite the latest construction. This, however, is easily understood when the secrecy which accompanies this particular portion of the manufacture is considered. We, of course, refer, not to the general plan of construction, but to certain details in the method of applying the percha to the conductor.

We find no mention of the tapeing or covering with hemp of the individual sheathing wires, although so far back as 1870 Messrs. Gray and Hawkins, of Silvertown, took out a patent for this purpose, and it is a method of protecting the wires in every-day use. We presume that M. Wünschendorff is aware that wires so covered have a breaking strain greater than the sum of the respective breaking strains of the iron and of the hemp. With regard to the employment of light cables, a term applied by M. Wünschendorff to unarmoured types, the author, in describing them as condemned, has failed to notice that the direction taken in the construction of deep water types, is towards a compromise between the completely sheathed and the totally unarmoured forms.

Among the various cable manufacturing machines described and illustrated we do not notice the one for tapeing or serving the sheathing wires; nor do we see any mention of the very ingenious mechanism devised for covering the core with a soft bedding, then with brass tape, and finally with a serving over the brass, the three operations being effected in the same machine. The purpose of these coverings is, of course, to protect the core against the ravages of insects.

It is to be regretted that M. Wünschendorff has entirely omitted the formulæ for calculating the quantities of the various materials required for the manufacture of submarine cables. A complete and accurate description of this portion of an engineer's work is all the more necessary since none of the text-books are, strictly speaking, up to date in this particular. This omission is, in our opinion, of far more consequence than the minor inadvertencies to which we have had occasion to refer.

A table is given of the mechanical data of a few submarine cables. If such a list were at all desirable, surely it might have been made more complete, since it is reasonable to suppose that no cable manufacturing firm or cable owning company would have been churlish enough to have refused such information. A table of this nature, with a column added showing the deepest water each type was laid in, would not only be interesting but instructive. We hardly share M. Wünschendorff's admiration for Hooper's core as a substitute for gutta-percha in submarine cables. We may be prejudiced, but we call to mind the experience gained with India-rubber cables on the Atlantic coast of South America. Unless we are very much mistaken, a decree of "anathema maranatha" was declared long ago against this material, not only on the South American coast, but also in the Persian Gulf, where gutta-percha has been chosen to replace India-rubber whenever a repair became necessary in the India-rubber cable.

A complete list of cable-laying ships, giving dimensions, tonnage, &c., would have been an interesting addition to the work. We notice that the author takes the *Faraday* as the best type of a cable-laying vessel, and the *Pouyer-Quertier* of a repairing ship. There seems to be no reason why this predilection should not be indulged in, since both vessels are excellent types, and it is generally admitted that the Messrs. Siemens make a point of studying every detail.

The chapter on cable laying is fairly satisfactory, but, as is the case in many other portions of the book, tables which would be of great utility, such as those of slack, strains, &c., are omitted. The example which the author gives of a cable weighing 0·5 klgm. per metre, in water (equal to about 0·9 ton), having a limit of 1,000 fathoms in which it can be picked up on the bight, supposing it is laid with a slack of 10 per cent., would be of more value were the breaking strain of the cable given. Take, for instance, the case of the 1865 and 1866 Atlantics; the cable weighed 0·7 ton in water, with a breaking strain of 8 tons. This cable was raised on the bight in 2,000 fathoms, and brought inboard, and but for the rough sea experienced, would probably have been secured. The slack at the point where the cable was hooked is given as 12 per cent.

As regards the utility of Messrs. Siemens's method of ascertaining the slack laid by means of paying out a wire at the same time as the cable is being laid, a system which M. Wünschendorff condemns, we are totally at issue with him. The contrivance is one of remarkable ingenuity, and is so arranged that during the whole of the paying out the percentage of slack is constantly indicated on a scale. The difficulties which at first presented themselves were chiefly the changing of the empty drum for one filled with wire, and the occasional breaking of the wire at these changes. These obstacles have been overcome, and we understand that so much as 500 miles of wire have been paid out without any mishap. By means of the wire register, the slack on one of the Atlantics, we forget which, was regulated to 8 per cent. exactly, during the entire passage. Odometers cannot be depended upon for any length of time; signals may not be obtainable, and yet it may be of the utmost importance to have the power of regulating the slack at any given moment.

The most amusing paragraph in the book is the mention of a suggestion made by a certain M. Quatrefages, who proposes to destroy the teredo by throwing into those waters infested by these insects, small quantities of any description of mercurial salts.

We cannot entirely agree with M. Wünschendorff's statement that the formula for calculating the dynamometer strains on a cable while being laid or picked up is incorrect and only applicable to a static strain, that is during grappling when the rope is made fast inboard. To a certaint extent he is correct, but to what degree we are unable to state. The length of grappling necessary for working in 1,000 fathoms is placed at 1,100 fathoms. Even under the most favourable conditions of speed and bottom this is too low a figure. We should imagine 1,200 fathoms of rope to be nearer the mark.

In the pages descriptive of cable laying, and in that portion treating of the forces of gravity and friction exercised upon a falling cable, we notice that M. Wünschendorff has copied figure for figure the diagrams, equations, and tables, given by Dr. Werner Siemens in his paper on submarine telegraphy, read at the Society of Telegraph-Engineers on February 9th, 1876. The inclusion of this information bespeaks active research, but we think that for the benefit of his French readers, the author might have given the source whence he derived his data.

Nor do we think that the author has laid sufficient stress on the fact that it has been a much disputed question whether the friction in a body passing through a liquid increases in direct proportion to the velocity, or according to the square of the velocity. As was to be supposed, M. Wünschendorff has followed Dr. Werner Siemens in adhering to the former proposition. The author seems to favour the employment of grappling rope composed entirely of manilla without any steel wires, on account of the less weight of the first mentioned type. His remark that such a rope has successfully resisted a strain of 9 tons is scarcely a sufficient argument since much greater strains must of a necessity occasionally be experienced in grappling work.

The chapters on the subjects of grappling and buoy rope, would have been more complete had tables been given of the various types of rope, their weights, and breaking strains.

In the description of buoys, the ingenious idea of Messrs. Johnson and Phillips, of letting go a temporary buoy, in a case of emergency and great hurry, with wire moorings carried in its base and automatically unwinding after the buoy has been let slip, is not mentioned. A very useful table might be constructed, for handy reference, of the dimensions and capacities of various sizes and shapes of buoys, with the amount of different types of grappling rope they respectively can support.

It may be very justly urged that such very complete details would necessitate a much larger treatise; if this view be adopted we then say that the work in many particulars is already too extended and unnecessarily inflated.

In dealing with the electrical branch of submarine telegraphy, the author has succeeded in collecting a mass of very valuable information. The instruments in general use are very fully described, but we think that a little more space might have been given to the construction of condensers and to the various forms of batteries.

Many methods of testing the internal resistance of batteries are given, but no mention is made of those in which a condenser is employed, such as Kempe's, or Munro's, or Muirhead's, which latter has a decided advantage over others, inasmuch as by it the polarisation of the battery is avoided, a most important point. The same chapter deals with the tests for the E.M.F. of batteries; several methods are described, but we remark as absent those of Wheatstone and Fahie, while Lumsden's method is ascribed to M. Lacoine, the fact being that Lumsden made use of this plan in 1869, and M. Lacoine *described* it in 1873.

The tests supplied to submarine cables during construction and submersion are fully dealt with, but we consider that some coefficient tables for the reduction of ordinary gutta-percha should have been given, the only one quoted being for Willoughby Smith's core.

In this connection we notice a very serious omission. No reference is made to the reduction of insulation tests when a cable is laid in varying depths where the temperatures will in consequence show great variations. The author reduces his insulation resistance from a mean temperature calculated from the conductor resistance of the whole circuit, a method, where different portions of a section lie in widely differing temperatures, productive of very serious errors. The correct plan being to divide the section up into as many portions as there are different depths, reducing each piece by the temperature actually observed at that depth.

The character of faults in cables, and the more important methods of localising them are treated in considerable detail, the subject being brought well up to date. There is little, however, but what may be found in Kempe's handbook.

The last portion of the work is devoted to the theory of the transmission of signals through submarine cables, and to a description of the more important systems and apparatus employed. Some of these systems are explained in sufficient detail, but there are others which appear to be too summarily treated to be of much practical use.

Taking the book as a whole, M. Wünschendorff is to be congratulated on the amount and variety of the information laid before his readers, and he deserves every credit for the exhaustive research evidenced throughout the volume. He is certainly the first who has ventured to tackle submarine telegraphy in such a comprehensive manner.

Journal of the Society of Telegraph-Engineers. No. 76. London: E. & F. N. Spon, 125, Strand.

The main contents of this number are as follows:—"Report of the Council;" adjourned discussion on Mr. Henry Edmunds's paper on "A System of Electrical Distribution." Along with this number the index for Vol. XVII. is published.

La Telegraphie Actuelle en France et a l'Etranger. Lignes, Reseaux, Appareils, Telephones. Par L. MONTILLOT, Sous-Directeur de Telegraphie Militaire, Professor a l'Ecole de Cavalerie de Saumin. Paris: Librairie J. B. Baillière et Fils, 19, Rue Hautefeuille.

It is difficult to justify the publication of this work (of 330 pages) for it certainly does not "supply a want," and as a text-book it is useless, for only descriptions of a few pieces of modern telegraphic apparatus are given. We can, however, say that the information supplied, such as it is, is well written and excellently illustrated.

ELECTROLYTIC INNER CELLS.

ATTENTION having of late been drawn to the question of porous pots or partitions for primary batteries, we propose offering to our readers a few remarks regarding the importance of this subject. The great disadvantage attached to primary, if compared with secondary batteries, apart from the question of cost, is the resistance introduced into the inner circuit through the employment of porous pots or partitions, which limits the possible output of electricity per unit of time. Many endeavours have, therefore, been made to dispense with the porous diaphragm, either by using only one electrolyte, that in itself is without chemical action upon the anode, or by giving the element the form of a gravity cell. In most cases, however, and notably in those of combinations giving very powerful currents, a porous material, capable of keeping two electrolytes separate for some time at least, has been found indispensable. If the pores, or channels, with which such

diaphragms are perforated, are of comparatively large diameter, the conductivity of the inner cell is, of course, less impaired than if the contrary is the case; but the diffusion of the two liquids on either side becomes great, and the waste, caused in consequence of ensuing "local action," serious, for which reason a porous partition, entailing a comparatively high internal resistance is, so to say, a necessary evil.

Messrs. Mayer and Liepmann maintain (as mentioned in our issue of the 1st inst.) that they have a process capable of minimising diffusion without increasing the resistance of a diaphragm to a corresponding degree. For this purpose they deposit suitable materials, such as silicic acid, in powder form, in the interior of the plates, thus transforming a channel of large diameter into a network of very small passages. It would appear at first sight that this was tantamount to an increase in the resistance of the plate, inversely proportional to the conjoined area of all the pores under consideration, before and after treatment. In reality, however, diffusion is diminished to a much larger extent than the conductivity, owing to the changed capillary conditions of the plates. It appears to us that the employment of substances like dehydrated silicic acid (to be used in non-alkaline solutions) is judicious and important, as causing the effect of the treatment to be permanent. "Gelatinous silicate of soda," on the other hand, as proposed by Messrs. Roberts and Brevoort, is liable to a series of changes in a galvanic cell, and will gradually become more or less dissolved. Their view of the action of the diaphragm—namely, that "gelatinous silicate of soda" (in a practical battery) was able to act as an electrolyte and to suffer such decomposition and recombination as is essential to the transmission of electric force—reminds us somewhat of the endeavour to reduce the internal resistance of a primary cell, by making the porous pot of carbon, *for the reason that this substance is a conductor of electricity.*

NOTES.

Electric Lighting at Devonport.—Arrangements are being made at Devonport with the view of lighting the various dockyard workshops by electricity. The improved illuminant has been used for some time past in the fitting shop and will eventually replace gas throughout the yard.

The City and the Electric Light.—At the meeting of the City Commissioners on Tuesday a report of the Streets Committee was presented on the subject of electric lighting, submitting draft conditions with a view to advertising for tenders. The report states that, having received and considered reports from the engineer, Mr. Preece, and the solicitor, the committee agreed that the conditions arranged the previous year with a proposed contracting company be taken as the basis of the new specification. That it should be obligatory on the companies with whom contracts may be entered into to lay all wires and conductors beneath the public way. That the City be divided into three districts, in accordance with the plan prepared by the engineer and Mr. Preece, and alternative tenders be invited for lighting the said districts and the City as a whole. That the main thoroughfares be primarily lighted, and be enumerated in the specification; and the companies proposing to contract be required to state the period at which the lighting of such thoroughfares will commence, and when it will be extended to the remaining streets. The commissioners not to be bound to light the whole of the streets by electricity. That it be a condition of any contract, that when the profits have reached a cumulative dividend of 10 per cent., the surplus be divided equally between the contracting company and the consumers. The conditions are appended. The area of the City which is to be lighted is for the purpose of the tenders divided into three districts as follows: No. 1, West District, comprising the area bounded on the north by the City boundary, on the east by Aldersgate Street, St. Martin's-le-Grand, St. Paul's Churchyard (north side), Creed lane, and St. Andrew's Hill, and thence along Queen Victoria Street to Blackfriars Bridge. On the south by the Victoria embankment, and on the west by the City boundary. No. 2, Central District, and comprising the area bounded on the north by the City boundary, on the east by Finsbury Pavement, Moorgate Street, Princes Street, thence across Mansion House Street, along Walbrook and Dowgate Hill; on the south by the River Thames, and on the west by part of Upper Thames Street, St. Andrew's Hill, Creed Lane, St. Paul's Churchyard (north side), St. Martin's-le-Grand, and Aldersgate Street. No. 3, East District, comprising the area bounded on the north and east sides by the City boundary, on the south side by the River Thames, and on the west side by Dowgate Hill, Walbrook, Princes Street, Moorgate Street, and Finsbury Pavement. The whole of the main thoroughfares in each district are to be lighted, and the following is a list of those thoroughfares:—District No. 1 (West): Holborn, Holborn Viaduct, Newgate Street, Charterhouse Street, King Street, Long Lane, Snow Hill, Chancery Lane, Fetter Lane, St. Andrew Street, Shoe Lane, St. Bride Street, Farringdon Street, New Bridge Street, Old Bailey, Fleet Street, Ludgate Hill, St. Paul's Churchyard (north side). District No. 2 (Central): Barbican, Beech Street, Fore Street, London Wall, part of (west of Moorgate Street), Gresham Street, Cheapside, Poultry, Watling Street, Cannon Street, part of (west of Dowgate Hill), Queen Victoria Street, Upper Thames Street (west of Dowgate Hill), Aldersgate Street, St. Martin's-le-Grand, St. Paul's Churchyard (south and east sides), Wood Street, King Street, Queen Street, Cripplegate Buildings, Milk Street, Aldermanbury and Aldermanbury Postern, Coleman Street, Basinghall Street. District No. 3 (East): Liverpool Street, Houndsditch, London Wall (east of Moorgate Street), Old and New Broad Streets, Bishopsgate Street Within and Without, Lothbury, Threadneedle Street, Cornhill, Leadenhall Street, Lombard Street, Fenchurch Street, Aldgate, Aldgate High Street, Gracechurch Street, Mansion House Street, King William Street, Cannon Street (part of, east of Dowgate Hill), Eastcheap, Great Tower Street, Upper Thames Street (east of Dowgate Hill), Lower Thames Street, Arthur Street East, Minories, Princes Street, Moorgate Street, Finsbury Pavement, Arthur Street West, St. Mary Axe. So far as the Commissioners are able to do so they will grant to the contractor the exclusive right of supplying electricity for private purposes within the district during the term of the contract. The contractor will be required to supply electricity to any owner or occupier of any premises within a distance of 25 yards of the mains, provided the owner or occupier enters into a fair agreement to defray or divide the cost of the service main, and to pay for the supply of the electricity. The contractor can charge the consumer for the amount of electricity supplied, either (1) by meter, or (2) by agreement. On the motion of Mr. Bridgman, the consideration of the report was adjourned.

The Report on Kensington Electric Lighting.—The main credit of the excellent report presented to the Kensington Vestry by the special electric light committee is due to Mr. Herbert Saunders, Q.C., who, both during the committee's investigations and in the preparation of the report, displayed an unexpected knowledge of the subject, and a marked capacity for dealing with it in a business-like, practical manner.

Electric Lighting at Exeter.—Last week the electric lighting company which has just been started at Exeter decided to proceed with its undertaking, a sum of £4,000 having been subscribed. Mr. Massingham having undertaken to put another £1,000 into the concern, the directors decided to order at once the first instalment of the plant. Premises in New North Road have been acquired and the company will commence operations as quickly as possible.

Wolverhampton and the Electric Light.—A scheme for lighting Wolverhampton with the electric light has been for some time under the consideration of a large number of prominent local manufacturers and others, and is now, we understand, almost completed. From various sources we (the *Midland Weekly News*) gather that a very powerful syndicate has been formed in London with a capital amounting to several million pounds, for the object and purpose of extending the use of electricity both as a luminant and motive power to London and all the large towns in the kingdom, The course of operations which, so far as at present known, the syndicate intend to pursue is to form in each town a local company which shall have the management of the scheme in that town. The London syndicate undertake to find a certain proportion of the capital necessary to promote the undertaking, and in return to receive an equal proportion of the profits. Here an influential gentleman has been entrusted with the work of forming a local company, and up to the present his efforts have met with every success, there being a very general and ardent desire on the part of local manufacturers and large shopkeepers to have the scheme successfully inaugurated, and their establishment supplied with the electric light. Some 20 or more gentlemen, including many of the most prominent local manufacturers, have already consented to join the company as first shareholders. The amount of capital which will be required has not yet been decided upon, but there is little doubt that it will be readily subscribed. The London syndicate has, it is stated, entered into certain important negotiations with Messrs. Elwell and Parker, of Wolverhampton, with reference to the business, patents, plants, &c., of the firm. These negotiations are on the point of completion, if not already completed, and will, it is understood, be ratified in the course of a week or so. The property of Captain Howard, at Gorsebrook, with certain lands adjoining, has been purchased, and it is proposed to transfer the business of Messrs. Elwell and Parker to this place, and erect there very large and extensive premises for the purpose of supplying the electric light to the various works in the town, and to private dwellings. It has been stated that Messrs. Elwell and Parker have purchased premises on the Stafford Road, and that they will enter into possession on the 25th March next, and at once, without any postponement, commence operations. The firm now employ about 500 hands, and it is anticipated that when they have taken possession of the new premises this number will be increased indefinitely. It is further stated that they will have no connection whatever with the new local company, but that it is extremely probable that they will receive the contract for supplying the light to the company. The correctness of the various statements, which are at variance with each other, will no doubt in the course of a week or so be ascertained.

Liverpool and the Electric Light.—A deputation, representing the Liverpool Electric Supply Company, last week waited upon the Watch Committee of the City Council, and endeavoured to procure their assent to the Provisional Order which the company intend to seek during the forthcoming session of Parliament. This consent has hitherto been withheld, as the Watch Committee have failed to induce the company to agree to conditions which are deemed to be essential in the interests of the public. The object of the interview was to endeavour to arrange terms which might be mutually satisfactory; but, in spite of an unusually protracted consultation, it was found impossible to come to terms, and the practical result, therefore, is that the Watch Committee will refuse their assent to the company's application.

Electric Lighting at the Paris Exhibition.—Messrs. Crompton & Co. are fitting up an extensive installation for lighting the whole of the English and American sections of the Paris Exhibition.

The Board of Trade and the Electric Lighting Companies.—Subjoined is a copy of a circular which has been addressed by the Board of Trade to various local authorities in whose districts roads have been broken up for the purpose of laying mains for electric lighting purposes:—"I am desired by the Board of Trade to state for the information of the vestry that their attention has been called to the fact that certain streets in the parish of —— have been, and are being, broken up with a view to the laying of mains for the supply of electricity by persons having no statutory powers under the Electric Lighting Acts, 1882 and 1888. The Board of Trade have been advised that no member of the public (and a company not possessing statutory powers would be in the position of a member of the public) can either with or without the 'assent of the local authorities interfere with public highways in such a way as to cause obstruction to the public, even though such obstruction were limited to the time during which they were executing their work.' It is, in the opinion of the Board of Trade, very undesirable that mains for the supply of electricity should be laid down in any street being a public highway by persons possessing no Parliamentary powers. The applications for statutory powers now before the Board of Trade show that there is considerable competition in the metropolis for the privilege of supplying electricity, and the difficulty of dealing with these applications in the general interest of the public will be materially increased if individuals or companies have laid mains without statutory powers, and consequently without the obligations which the Legislature has imposed for the protection of the interests of the public. It must also be remembered that the financial interests of electric undertakings which occupy streets with their mains, and supply electricity to the public without statutory power, are by no means secured in the same way, and to the same extent, as if they possessed those powers, since, in the first place, their works run the risk of being stopped by the direction of a court of law at the instance either of some public authority, or of anyone who may at any time, now or hereafter, feel himself aggrieved; and since, in the next place, they do not possess the remedies for enforcing against their customers their charges, which the Legislature has given to those who obtain statutory powers. The status of applicants to the Board of Trade, and through them to Parliament, should be such as to ensure perfect equality to all, and there is danger that this might not be the case if any persons—either being or about to be applicants for statutory powers—were in the actual occupation of streets. It has become, therefore, necessary to consider the action which may have to be taken in view of the facts above referred to, and I am desired to request the early observations of the vestry upon the points mentioned."

Electric Lighting in Nottingham.—An electric lighting company is being formed in Nottingham in connection with a London company, for the purpose of supplying various parts of the town, especially the Park and the neighbourhood of the Castle, with the electric light on advantageous terms. A strong local committee has been formed, and the company—the shares in which are being taken up locally—will be registered in a week or two.

Cork and the Electric Light.—At a meeting of the electric lighting committee of the Cork Corporation last week, communications were read from cities and towns in England, as well as from the city of Waterford, where the electric light has been for a long time in use. The several replies to the Town Clerk's enquiries from these places on the subject were considered favourable, and the committee recommended to the council that they consider it desirable to light the city by electricity, and asked that power should be given to the committee to invite tenders from several electric lighting companies, with the view of ascertaining the cost.

Electrical Transformers.—Too late for insertion with "Correspondence," we have received the following from Mr. H. St. John Winkworth, of the House-to-House Electric Light Supply Company :—"I read with much interest the letter from 'Onlooker,' in your last week's issue, but I regret that that gentleman has not carefully read the claim which is being put forward at the present moment by my company, which is that the station which the company has recently opened in Kensington is 'the first completed station *in the metropolis* designed for the accomplishment of electric lighting over a large area by means of underground mains.' At some future day this claim will only have a historical interest, but my directors would be sorry to put forward a claim which was incorrect, and in doing so they do not by any means ignore the work which is being done by the Kensington Court Electric Light Company, but from Mr. Erskine's recent letter in the *Times* it is evident that that company do not claim to be working over an extended area. It would be out of place to trespass upon your space by drawing attention to the various opinions which have been held from time to time as to the proper area for electric lighting, but it will be no doubt of interest to your readers to know that a high tension system, such as that which has been installed by us in our Kensington station, is able to cope with a large area, which a low tension system, like that adopted by the Kensington Court Company, could not cope with. Your correspondent's information in reference to the Zipernowski-Deri-Blathy system is most interesting, but as they have not laid down a central station in the metropolis, the gentleman signing himself 'Onlooker' must see that Signor Emilio Magatti's letter has no bearing whatever upon what he calls the repeated positive assertions of the House-to-House Company that theirs is the first completed station in the metropolis for carrying out the work in the manner described."

Electric Lighting in London.—The Roads Committee of the St. George's (Southwark) Vestry last week recommended the Vestry to dissent from the granting of a provisional order to the London Electric Supply Corporation, and to assent to the granting of a licence to the House-to-House Company. The recommendation was not passed, further consideration of the matter being adjourned for three weeks. At the meeting of the St. Luke's Vestry the Parliamentary and Improvements Committee submitted recommendations favouring the proposal of the London Electric Supply Corporation upon certain conditions being observed for the satisfaction of the Vestry. These recommendations were adopted. At the Lambeth Vestry the Electric Lighting Committee submitted an exhaustive report, in which they recommended the Vestry to oppose the applications of both the London and the Metropolitan Electric Supply Companies, with the view of inducing either one of these, or some other company, to agree to clauses requiring the laying down of trunk mains in certain streets within a definite time, and that all wires should be laid underground unless the Vestry consented to some other course. The recommendation, after a lengthy discussion was adopted. The Whitechapel Vestry has decided to "stand by," neither assenting nor dissenting.

Birmingham and the Electric Light.—The General Purposes Committee of the Birmingham City Council have reported that it is not desirable that the Corporation should at present acquire powers to supply electricity, but they have not been able to come to terms with Messrs. Chamberlain and Hookham, who are promoting an application for a Provisional Order for a similar purpose, and who have hitherto declined to insert certain clauses with regard to area, capital, and deposit. The committee, therefore, recommend that the council should withhold its consent to the application. At its meeting on Tuesday the council accepted the recommendation of the committee with regard to opposing Messrs. Chamberlain and Hookham's application.

Trunk Lines in the West.—On Thursday last week the Western Counties Telephone Company's trunk line between Cheltenham and Gloucester was formally opened, and telephonic communication has thereby been established between Cheltenham and Gloucester, Bristol, Bath and other large towns in the West and South of England, and also with Cardiff and other large towns in South Wales.

Professor Jamieson's Paper.—The long letter which we publish from "One of These," looks suspiciously like the joint efforts of several; indeed, we feel that there is something of inspiration about it. Perhaps in our next we may refer to several of the points brought forward in the communication, but in the meantime we may inform our correspondent that we understand the papers which are read before the Institute of Electrical Engineers will be forwarded in due course to the technical press, the discussions only being kept private.

St. James's Hall Installation.—We understand that St. James's Hall is being entirely rewired and supplied with new and improved fittings, the order for the work being given to the Acme Electric Works.

Willis's Ship's Telegraph.—We understand that this telegraph has been fitted to the ss. *Imperieuse*, *Camperdown*, *Rodney*, *Aurora* and *Vera*. Messrs. Elliott Brothers are also at present engaged in fitting the *Magicienne* and the *Marathon*, the whole of the work being executed by that firm. Orders are also in hand for H.M.S. *Galatea*, *Medea* and *Medusa*; we also understand that the Royal Yacht, *Victoria and Albert*, is to be fitted with the apparatus; the invention generally has been adopted into the Navy. A set of the engine room telegraphs was, by permission of the Lords Commissioners of the Admiralty, sent to Portsmouth in order that the officers of H.M. Navy might have an opportunity of making themselves acquainted with the construction and testing of the instruments. At the request of the Admiralty a large number of officers did this and their reports were unanimously favourable. It may be added that Captain Potter, R.N., of the ss. *Vera*, reports that the instruments fitted to that vessel have worked continuously for 9 months without a single false indication having been given and without attention of any kind.

The Brooks Underground Telegraph System.—We have received from Mr. David Brooks a pamphlet descriptive of his most recent form of underground cable. Fully illustrated descriptions are given of the plant employed for laying the system. The insulating medium is a mixture of rosin and rosin oil which take the place of the paraffine oil originally used. The letter from Professor Kendall, which we published some time ago, giving results of his tests is printed at the end of the pamphlet, and also a letter from Mr. Jaggard, the tests being highly satisfactory.

India-Rubber Trade in Burmah.—We read in *Industries* that the trade in India-rubber on the Chinduin River is assuming very large proportions, and that the material exported is of a very good quality. Although this industry has been established since 1887 only, the trade has so much increased that an export duty has been placed on the raw material, as well as the imposition of an annual licence on all traders. The business has enormously increased since the expiration of the monopoly granted in 1887 to a Chinese syndicate in Bhamo. An English company in the Chinduin is doing a very satisfactory trade, notwithstanding vigorous competition at the hands of the Chinese, since the natives prefer dealing with Europeans.

The Central Subway.—A meeting in connection with the London Central Subway Railway, for the construction of which powers are to be sought in Parliament, was held last Friday evening at the Holborn Town Hall. There was a large attendance, consisting for the most part of tradesmen and others interested in the proposed initial line of route. The scheme was explained at considerable length by its projector, Colonel Rowland R. Hazard, who illustrated his remarks by means of a sectional model of a similar railway now running underneath Broadway, New York. The line would run under the roadway between the kerbs, at a depth of 12 feet, on a solid concrete bottom of 2 feet in thickness. The outer walls would be of brick and 2 feet thick. It was intended, he said, to construct four tracks of the standard gauge of 4 feet 8½ inches, separated by steel partitions, and the side galleries were to be utilised in many ways, notably for the accommodation of water and gas pipes, telephone wires, pneumatic tubes, &c. Express and slow trains, worked and lighted by electricity, would be run at intervals of two minutes, on the respective tracks. It was estimated that the cost of the line would be £750,000, and that it would take only six months to complete. In the course of answering numerous questions, Colonel Hazard stated that at present six stations had been arranged for. The depth of the subway was so slight that the excavations would not touch the foundations of the houses adjoining the line, and the vibration would be scarcely, if at all, perceptible. Mr. Sydney Morse, the solicitor to the promoters of the scheme, also explained various points of law, chiefly in connection with the question of compensation to property owners.

Institution of Electrical Engineers.—At the ordinary general meeting on Thursday, February 14th, the discussion on Prof. Jamieson's paper, "The Insulation Resistance of Electric Lighting Circuits," will be concluded; and a paper by A. E. Kennelly, Associate, on "certain phenomena connected with imperfect earth in telegraph circuits," will be read.

The Electrical Omnibus.—Another successful journey was made in the West End on Tuesday by the new electric road car. It was steered without any difficulty over about four miles in 35 minutes, and the trial was considered very successful.

Newspaper Science.—The following cutting from the *Whitehall Review* is too good to be lost:—"So far from the electric light pushing gas from the field, it is now being discovered that the managers of electric light stations are likely to become good customers to the gas works. Intense heat is required for the purpose of heating the dynamos, and this cannot well be secured by the use of ordinary coal. Then, again, the coal specially adapted to the business is very expensive—so much so, indeed, is this the case that the officials of one large electric light station are contemplating laying on a main of gas whereby to get the heat required for the dynamos."

County Councils.—Mr. Slater Lewis, the managing director of the Telegraph Manufacturing Company of Helsby, has been elected a member of the Cheshire County Council by a majority of 107 votes over his opponent, Mr. Reynolds, a popular local magistrate.

Alkaline Accumulators.—Mr. P. Bedford Elwell writes to us as follows:—"I hope Mr. J. C. Richardson will not for a moment imagine that I have overlooked the important work done in alkaline primary cells by Mr. de Lalande, with whom I have the honour of being personally acquainted. My object was to give the only *practical* results I had heard of in the invention of alkaline *secondary* cells. The combination of copper-caustic potash-zinc was, I believe, used by Faraday many years ago, and Mr. de Lalande has obtained very good results from his improvements in that field. That his cells do *not* act favourably as *accumulators* is, I think, freely admitted by all connected with them."

Electricity and Private Bills.—The Metropolitan Electric Supply Company's bill, which empowers that company to supply light by measurement in St. James's, Westminster, and St. Martin's-in-the-Fields, has been declared by the examiners in Parliament to have complied with the Standing Orders. This is of course only the first step in the progress of the Bill through Parliament. Among other Bills which have passed the same stage are the Metropolitan Railway Company's Bill authorising an extension of their system to Chesham for a distance of about a mile, and the use of electricity as the motive power; and the South Staffordshire Tramways Company's Bill in which, *inter alia*, they ask power to work the tramways by cable "or electric traction."

Drop-Forged Commutator Bars.—One of the most important parts of the dynamo and motor is the commutator, says the *Electrical World*, and the construction of a strong and durable segment has occupied the attention of many inventors. The usual method of construction has been to build up the segment of two bars placed at an angle and soldered or brazed at the joint. For some time past the Billings and Spencer Company, of Hartford, Conn., has produced commutator bars of a single homogeneous piece of copper. The process permits of bars being made of all shapes and sizes, and furnishes a bar of the highest conductivity and strength. These bars are said to have already become very popular with the manufacturers of dynamos and motors.

The Status of the Julien Storage Patent.—The Electrical Accumulator Company has made the following communication to the *Electrical World*:—The *Electrical World*, of December 22nd, 1888, contains a statement from the Julien Company, by which it is made to appear that the application of the Electrical Accumulator Company for a certain patent has been refused by the United States Patent Office. Such a statement is not true; on the contrary, the Commissioner of Patents, Washington, has just rendered a decision sustaining the claims of John S. Sellon as the inventor of an inoxidisable alloy support plate, and Mr. Sellon's patent has been passed to issue, and will shortly appear on the patent records duly assigned to the Electrical Accumulator Company. The application of Sellon was founded upon the specification of his English patent, No. 3,987, dated September 15th, 1881. This British patent of Sellon's is the first publication to describe the use of a plate of lead and antimony, or an alloy of two metals, either with or without the use and application of an amalgam as a support for the active material in a battery of the Faure type. The issue of this patent in the United States will enable the assignee of Sellon, the Electrical Accumulator Company, to control the manufacture, use, and sale of secondary batteries employing lead and antimony in the composition of the support plates, whether mercury to form an amalgam be present or not, and suits will be instituted in the courts for the recovery of damages at once.

Electric Smelting Patents.—An application for United States patents, made in 1886 by M. Camille A. Faure for electric smelting processes, was thrown into interference with the patents for the same purpose granted to Messrs. Cowles, and testimony in the suit has just been taken at Lockport, N.Y., by the Cowles Electric Smelting Company.

Electric Street Railways.—The Sprague Electric Railway and Motor Company of New York has closed a contract for the electrical equipment of the Chattanooga Electric Street Railway. The Electric Street Railway Company at Chattanooga has been only recently organised, and the construction of the road will be new throughout. The line will extend over five miles of track, and there is a number of sharp grades which must be surmounted. The system used will be the regular Sprague overhead, with small silicon bronze overhead wire for a working conductor.

A Paragon Amongst Men.—Mr. Goodstall, whoever that gentleman may be, elicited some very interesting statements from Sir John Pender at last week's meeting of the Eastern Telegraph Company, but we doubt whether the autocrat of the cable ring was quite happy in the explanations he gave to account for the existence of one of our most valued contemporaries. The journal in question, we learn, was established for the purpose of getting the best scientific opinion upon matters relating to the cables owned by the companies with which Sir John is connected; but can it be truly said that this object has been achieved? Are not writings, especially those of a scientific character, upon submarine cables and their adjuncts, rather conspicuous by their absence in the pages of the magazine established by Sir John Pender, Sir James Anderson, and another for their young men all the world over? We are inclined to the belief that articles relating to telegraphy generally are more often to be found in the columns of the ELECTRICAL REVIEW than in any other technical paper, although we do not make that important subject our special province. One gratifying item in this great and good man's speech is that he and his friends have not taken a shilling profit out of the proceeds of the sale of the journal, their only interest being that a thorough knowledge of telegraphic science should be disseminated all over their telegraphic system.

Electrical Omnibuses.—The leader in the *Standard* of Thursday seems to have been based upon the assumption that the electrical omnibuses and other vehicles which Mr. Radcliffe Ward contemplates putting on the London streets will rush about hither and thither in an utterly irresponsible and uncontrollable manner, and at the breakneck speed of a fire engine. We fail to see any increased danger to the public if the new vehicles should travel even at the rate of a hansom cab, a rate which will probably be very rarely reached.

St. Catherine's Lighthouse.—In last week's *Graphic* appears a two page sheet of admirable sketches of St. Catherine's Lighthouse and its electrical machinery. One in particular shows the lamps with its fluted carbons, 2½ inches diameter, six pointed, star-shaped. Upwards of 20 electrical horse-power are consumed in this one single arc, and as absolute steadiness of the arc is vital to the optical requirements of the lantern, the form and quality of the carbons become of the utmost consequence. This fluted form of star-shaped section was originally proposed by Sir James Douglass, and its use at St. Catherine's for the heavy currents of upwards of 300 ampères has contributed in no small degree to the success of the light. These carbons are supplied to the Trinity House by Messrs. Lacombe & Co. of 7, Little Queen Street, Westminster, the well-known carbon manufacturers. We understand that their fluted carbons are now greatly in favour with the leading electrical firms for use in projectors and search lights with large currents.

Prof. Tyndall says that a trained observer whom he sent down to the Isle of Wight last autumn, to watch the electric light at St. Catherine's Point, saw that light go completely out seventeen times in three hours, sometimes for more than a minute. Observing the lighthouse in a thick fog, he was unable to see the light at a distance of 500 yards.

Berly's Universal Electrical Directory, 1889.—The new edition of Berly's Directory shows an increase of 49 pages as compared with 1888, and as all technical matter, tables, formulæ and such like matter are excluded as foreign to the subject of the publication, the whole contents are valuable to manufacturers, dealers, electrical and mechanical engineers and others. It bears evidence of the same amount of careful editing as in past years, and appears to be as near as possible correct to date.

The School of Electrical Engineering and Submarine Telegraphy.—In consequence of the recent reorganisation of the advanced instruction, which is now under the charge of Mr. Charles Capito, Memb. Inst. Mech. Engineers, the managers recently requested Mr. Gisbert Kapp to undertake the examination of the Advanced Class. One day was devoted by him to an examination in practical work, such as engine running, boiler firing, dynamo and lamp management, joint making, &c., and a second to papers in mechanical and electrical engineering. Out of seven students examined, three were awarded the certificate of the school, Messrs. Hawkins, Rowlet and Graves, the average percentage of marks gained by them being respectively 87·3, 78·8, and 65·8. A minimum of 70 per cent. in the practical work, and 60 per cent. in the two papers is a necessary condition of obtaining the certificate. We may add that, as the result of former examinations, Mr. Fletcher has also recently gained the certificate.

Belting.—Messrs. Thos. Fleming, Son & Co., issue an annual price list in the form of a diary which, besides a large amount of useful information as to the properties and management of machine bands, gives a number of notes on various commercial subjects, such as county court procedure, trade marks, income tax, the Bankruptcy Act, and mercantile law as affecting the sale and purchase of goods, payment of accounts, agency, and a number of other matters. It is therefore a handy book for reference on these points.

City and Guilds of London Institute Old Students' Association.—The next meeting of the Old Students' Association will be held at the Central Institution, Exhibition Road, on Wednesday next, when a paper on "Petroleum" will be read by Justus Eck, Member. A smoking concert will be held on Saturday, 23rd inst., at the Manchester Hotel, Aldersgate Street, at 7.30 p.m., and the secretaries will be glad to receive offers of assistance from members as soon as possible.

NEW COMPANIES REGISTERED.

Michoacan Railway and Mining Company, Limited. Capital, £300,000 in £10 shares. Objects:—To acquire a concession from the Mexican Government for the construction of a railway from Maravatio to Angangulo and Zitacuaro, and thence through Sultepec to Iguala, also to carry on generally the businesses of a telegraph company and a telephone company in all their respective branches. Signatories (with 1 share each) J. C. Huxtable, Holland Park Gardens, W.; E. Wood, 32, Lothair Road, N.; F. C. Dyer, 10, Gladys Road, N.W.; E. A. Culverhouse, 83, Rushmore Road, Clapton; F. J. Gibson, 13, Great Turnstile, Holborn; W. H. Bracey, 9, Savernake Road, Mansfield Road; J. Singleton, 80, Balcombe Street, N.W. The first directors are Messrs. R. M. Brereton, F. Nettlefold, J. S. Sellon, R. R. Symon, A. G. Renshaw, C. W. Mackellop, E. H. Carbutt and Major Shepherd, R.E. Qualification, £300 in shares. Minimum remuneration, £1,000 per annum. Registered 29th January by R. S. Taylor, Son and Humbert, 4, Field Court, Gray's Inn.

Taunton, Delmard, Lane and Co., Limited.—Capital, £125,000 in £10 shares. Objects:—To carry on business as mechanical, chemical, electric, scientific and general engineers, and for such purposes to take over the businesses of R. H. Taunton and Hayward of the Star Works, Heneage Street, Birmingham; Maurice Delmard of Old Charlton, Kent; the Patent Steam Boiler Company, of Birmingham and of Howard Lane & Co., of Palmerston Buildings, London. Signatories (with 1 share each) *M. Delmard, Old Charlton; H. Lane, 115, Palmerston Buildings; R. A. P. Taunton, Solehull, Birmingham; *R. H. Taunton, Birmingham; *J. P. Williams, M.P., Edgbaston; *F. B. Goodman, Edgbaston; T. Casson, Aston, Birmingham. The

signatories denoted by an asterisk are first directors with power to appoint Messrs. H. Lane and R. A. P. Taunton as additional directors; remuneration, £315 per annum, to be divided as they may determine. Registered 29th January, the solicitors to the company being Messrs. Smith, Pinsent & Co., Birmingham.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

South Metropolitan Electric Supply Company, Limited, recently changed to the **Metropolitan Electric Supply Company, Limited.**—The annual return of this company, made up to the 5th April, was filed on the 22nd ult. The nominal capital is £250,000, in £10 shares. Although incorporated in 1887, the only shares recorded as taken up are the seven subscribed for by the signatories to the memorandum and articles of association.

At an extraordinary meeting of the company held at Winchester House on the 8th, the following special resolution was passed, and was confirmed on the 25th ult.. and filed on the 29th ult., viz.:—

Resolved:—That the articles of association be altered as follows:—

Article 26.—By striking out the words "A director may act before acquiring his qualification."

Article 45.—By adding at the end of this article the words: "Provided that the powers of borrowing and raising money, and of making and raising mortgages or debentures or debenture stock, obligations, or other securities, shall not at any time, without the sanction of a general meeting, be exercised to such an extent that the total amount of principal money borrowed, raised or secured shall not exceed the nominal amount of the share capital for the time being; but this restriction shall not oblige any person taking any mortgage or debenture or debenture stock, obligation, or other security of the company, to enquire whether there has been any such excess, or affect the validity of any such security in the hands of a *bona fidé* holder, nor interfere with the power of the directors to make and enforce calls."

Article 102.—By striking out the words: "A director shall not be appointed auditor," and inserting in lieu thereof the words, "No director or any other officer of the company shall be appointed auditor."

Article 119.—By inserting after the word "shares" the words: "Not fully paid."

Article 121.—By inserting after the word "writing" the words: "Which may be in the usual common form.

Article 123.—By inserting after the word "share" the words "Not fully paid up."

Article 130.—By striking out all the words except the words "Every shareholder shall be entitled to one certificate for his share gratis, but in every other case one shilling shall, when the board think fit, be paid to the company for every certificate."

Article 125.—By inserting after words "shares" in line 2, the words, "Not fully paid up."

An agreement of the 3rd ult., filed on the 31st ult., between the Metropolitan Electric Supply Company, Limited, and the Whitehall Electric Supply Company, Limited, cites that by an agreement of 17th July it was arranged that this company should purchase the undertaking and property of the Whitehall Company for £79,888, payable to the extent of £60,000 in fully paid ordinary shares. By an agreement of 12th December, 1888, the former agreement was varied by the substitution of £40,211 as purchase money, of which £20,320 should be payable in fully-paid shares. Under the present agreement the company will forthwith allot the said shares.

Gülcher (New) Electric Light and Power Company, Limited.—The statutory return of this company, made up to the 31st December, 1888, was filed on the 1st inst. The nominal capital is £70,000, divided into 20,000 ordinary and 50,000 preference shares of £1 each. The whole of the ordinary and 12,271 preference shares have been allotted; the former are issued as fully paid up, and the full amount has been called and paid upon the latter.

E. Page and Company, Limited.—An agreement of the 15th ult., filed on the 18th ult., provides for the purchase of the business of agricultural, marine, mechanical and electrical engineers, carried on at Bedford under styles of E. Page and Company and the Bedford Ironworks Company. The purchase consideration is 29,700 fully paid shares of £1 each, and the undertaking and discharge of the debts and liabilities of the said business. Registered office, 59, High Street, Bedford.

Leete, Edwards and Norman, Limited (engineers and electricians).—The annual return of this company, made up the 3rd ult., was filed on the 7th ult. The nominal capital is £20,000 in £5 shares. 1,486 shares are allotted, and the full amount has been called thereon, 1,110 being considered as fully paid. The calls paid amount to £5,550, and unpaid to £30,

LEGAL.

Watt v. Maxim-Weston Electric Light Company.—In the Chancery Division of the High Court of Justice on February 1st, before Mr. Justice North, Mr. Higgins, Q.C., moved on behalf of the plaintiff for an interim injunction to restrain the defendants until the trial of the action or further order from carrying into effect a scheme of reconstruction of the defendant company as resolved upon by certain resolutions dated December 21st, 1888, and January 7th, 1889, and also from entering into and carrying into effect the agreement referred to in the scheme: or, in the alternative, for an injunction to restrain the defendants, the letters patent, and assets of the company in pursuance of the scheme until reasonable security for the amounts payable to the plaintiff should have been provided. Mr. Cozens Hardy, Q.C., said the defendants were prepared to maintain that the proposed reconstruction was regular, and that the security given to dissentient shareholders was ample; but at the same time the defendants were willing to deposit in the joint names of the solicitors a sum which would satisfy the plaintiff. Mr. Justice North directed the motion to stand till the trial of the action, the costs of the motion to be costs in the action.

CITY NOTES, REPORTS, MEETINGS, &c.

Anglo-American Telegraph Company, Limited.

THE ordinary half-yearly general meeting of this company was held at Winchester House, Old Broad Street, E.C., on Friday, the 1st inst., the Right Hon. Viscount Monck presiding.

Mr. T. H. Wells, the secretary, having read the notice convening the meeting, the report of the directors, published in the REVIEW last week, was taken as read.

The Chairman, in proposing the adoption of the report and accounts, first expressed his acknowledgments to the shareholders for excusing his absence upon the occasion of the last meeting. The illness from which he then suffered had now disappeared, and had left no serious effects. Proceeding to the business of the meeting, he said that on those occasions the topics for discussion were not very extensive, lying within a narrow range. When they had discussed the condition of their plant, the expense of maintaining and repairing it, the revenue which they derived from its working, and the prospects of the company, they had almost exhausted the category of subjects with which it was open to them to deal. He wished to say a few words upon each of the heads he had named. With regard to the plant, they would observe in the report that, with comparatively trifling exceptions on the other side of the Atlantic, it was in a good condition. They had had a good deal of repairing to do during the half year, and there were one or two observations to be made in connection with the repairs which he thought were not wholly unsatisfactory. In the first instance, the repairs had been done entirely by their own steamer. The possession of this vessel gave them the advantage, in the first place, of having their repairs done at first cost, which demonstrated the necessity which existed for keeping a repairing ship. There was further to be considered in this prospect the condition of the cables which had been repaired. Their deep sea cables had all been in good order excepting the cable of 1869, the original French cable, in which they had had very considerable repairs to effect. They picked it up at two or three places in upwards of two thousand fathoms of water; they got it up safely and repaired it. They would perhaps remember that that was the oldest cable in the Atlantic which was transacting business. He could speak from personal recollection about it, as

he was chairman of the company which originally laid it; it was now in its twentieth year. It had been doing good business, and they had been enabled to put it in thorough repair this year. With respect to the expenses which had been incurred, independent of the cost of repairs and renewals, there was not much to be said. They had all through the half year attended most carefully to the expenditure, and had endeavoured to reduce it as much as possible. But if they would take the trouble to compare two or three of the annual reports, and look at the details given, he thought they would find that there was a very small portion of the expenditure over which the directors could exercise any great power. They must pay their wages, they must feed their people, and they must maintain their lines. He did not think they would find, on a comparison, that there was very much difference between any of the last few half years. As a matter of fact, the expenditure of the present half year appeared, on the face of it, to be £1,000 less than in the corresponding half of last year; but when they came to look into it, they would find that there were some extraordinary expenses in that half year which really took the matter out of the category of comparison. There was one item in the expenditure to which he would draw their attention, because it put them in a position of safety as to the future. That was an estimate which they had made as to the cost to which the French law suit was likely to put them. They had debited themselves with £2,000 in reference to those costs, and they believed that that was an ample estimate of what they ought to come to, and therefore they would not appear again, he hoped, in their accounts. With regard to the income and the prospects for the future, they met that day under conditions, he was happy to say, which, if they did not give rise to any very effusive jubilation, were, at all events, more satisfactory than those that were before them at their last meeting. It would be within their recollection that in July, 1887, their directors announced that their policy was to adopt a very small rate of tariff, not as a fighting measure, because the usual object of a fighting tariff was to make your adversary increase his tariff; they announced a very low rate of tariff not as a hostile tariff, though to a certain extent there must be hostility in every competition, but they announced their desire to test by experiment what tariff was the lowest they could give the public consistent with making a living themselves. They announced at the time that they intended to maintain the sixpenny tariff for a period long enough to give them experience of its effects, and he might say that, as no doubt most of the stockholders were aware, the receipts at different seasons of the year varied very considerably, and therefore an experiment made, say, in the autumn, would not be a sure guide with reference to the whole year. They maintained that sixpenny tariff for more than a year, and he thought they proved to the thorough dissatisfaction of everyone concerned that in the present condition of telegraphy in the Atlantic, a sixpenny tariff would not pay adequately. The result of that was that they received propositions for an increase, and the rate was now a shilling per word. The experience they had so far had of the new rate, for the reason he had already mentioned, was not long enough to give them any just reason for deciding whether the shilling tariff was a satisfactory one, on the whole, or not, but up to that time it had not been unsatisfactory. He trusted that the same reasonable conduct which induced the different companies which were engaged in telegraphy in the Atlantic to take the step of raising the tariff to a shilling would also induce them to go further if it became absolutely necessary in order to gain their living. As he had already said, the period during which the shilling tariff had been in operation had been too short, and affected too small a portion of the year, to enable them to arrive at a definitive decision as to the propriety of maintaining it. But he hoped that they might be able, by the exercise of moderation and forbearance towards their adversaries, to bring about a tariff which, without bringing them in such large returns as to induce further competition, would yet give them a moderate and remunerative return for the money they had invested in the concern. With these remarks he begged to move that the report of the directors and the accompanying statement of accounts to December 31st, 1888, submitted to the meeting, be received and adopted.

The Marquis of Tweeddale seconded the proposition.

Mr. Smith, of York, congratulated the directors on the results of the half year, and approved the course they had taken in raising the tariff. He asked one or two questions as to the French lawsuit. He believed it was the custom in the French Courts, when damages were awarded, for those damages to be immediately handed to the plaintiff. The Paris and New York Company had been mulcted in damages to the extent of £80 a day from December 31st, 1886, to the date of the service of the judgment; had that money been paid to the Anglo-American Company?

Mr. Guesdon having spoken in approval of the action of the directors generally,

Mr. Chipperfield strongly condemned them for having initiated the sixpenny tariff, which he believed had been the cause of great deprivation to many poor people who depended upon regular dividends from this company.

Mr. Wood thought the sixpenny rate was bound to be the rate of the future.

Mr. Jackson said it was often said that the electric light was the light of the future, but of what future nobody seemed to know.

Mr. Picton, Mr. Humphries and other shareholders having spoken on matters of detail,

The Chairman, in reply, referring to Mr. Chipperfield's denunciation of the directors for reducing the tariff to 6d. a word, that it would be recollected that when the postage rate was high throughout the country the Post Office did not pay its own expenses; but after the reduction to a penny, in a few years it became a source of revenue to the State, and was now a very large contributor. He was asked a question with reference to the probable life of the 1869 cable. All he could say was, that he hoped it would last a very long time; but he might tell them that wherever that cable had been picked up under favourable conditions from the bottom of the sea, it was as good as on the day it was laid down. There were one or two points between this and America where the unevenness of the bottom of the sea caused a great deal of friction and rupture. They had so often repaired the 1869 cable that he had once remarked that it must be like the knife which had a new handle and a new blade but still passed as the same knife. But Mr. Weaver told him that he was never more mistaken in his life and pointed out to him by means of the chart that all the breakages occurred at very nearly the same spot where the unevenness of which he had spoken was to be found. So that as far as they could learn from experience, that cable was likely to last many years longer. With regard to the French suit, he would call upon the solicitor, Mr. Burt, to state how that matter stood.

Mr. Burt said they would probably remember that their action against the Paris and New York Company was commenced in the Tribunal of Commerce in Paris. In that Court they obtained a very satisfactory judgment. The defendants appealed to the Court of Appeal in Paris. That Court, while expressing itself, as it appeared to him, decidedly in favour of the Anglo-American Company's claim, doubted whether the Tribunal of Commerce possessed jurisdiction to give the decision which it gave. In the concession given to the French Company it was stipulated that any question between the Government and the holders of the concession should be decided, not by the ordinary law courts, but administratively by the Conseil de Prefecture of the Seine, with right of appeal to the Council of State. The Court of Appeal therefore said: "Before we decide this question you must go to the Conseil de Prefecture of the Seine, in order that they may, in accordance with the terms of the concession, determine what is the legal value of the letter written by the Minister of Posts and Telegraphs to the company, upon which they broke the contract." The hearing before the Conseil de Prefecture was now pending, and was to be heard on the 26th of this month. But he could not hold out the hope that that would be the end of the matter. Probably whichever party was defeated would appeal to the Council of State. Then when the final Court had decided upon the administrative question, they would have to go back to the Court of Appeal. The £2,000 in the accounts was estimated to be the proportion of this company's expenses in the French Courts. He, having had considerable experience in both countries, might say that the expenses in France were quite equal, if not superior to, those in our own tribunals. With regard to the question of Mr. Smith, as to whether the Paris and New York Company had paid over the damages given against them; first of all, it was not possible to obtain the deposit in the Tribunal of Commerce of the damages which were alleged. If it had been done, they would have had to give security for the return of the money, together with compensation for all the losses that the company sustained through deprivation of the money. They were advised by the ablest lawyers they could find in Paris that it would be wiser not to ask for the deposit on that account.

The resolution was then put and carried unanimously.

Mr. Jackson asked permission to move a recommendation to the directors to take special notice of the great services rendered to the company by Captain Trott in carrying out repairs in the Atlantic with great promptitude, and under great difficulties.

Mr. Smith seconded the proposal.

Mr. Guesdon hoped this resolution would not be put, as it would be an interference with the duties of the directors, whom it would considerably embarrass if passed.

The Chairman said he could assure the stockholders that his colleagues, as well as himself, most highly appreciated the services and the knowledge of Captain Trott, but he must say that, on general principles, he entirely agreed with Mr. Guesdon in the view he took of the proposal. If they, as directors, were to manage the business, he thought the less the interference with the details of that business on the part of the stockholders, the better they would find the work done. They had no wish to detract in any way from Captain Trott's merits; they appreciated them. But he would ask the shareholders not to pass the resolution, in consideration of the general principles which ought to guide them in their relations with their directors.

Mr. Jackson expressed his disappointment at the manner in which his proposition was received, but withdrew it.

Sir James Anderson and Mr. W. S. Cunard were re-elected directors, and the auditors, Messrs. Joshua Deane and Francis Glass were reappointed; a vote of thanks thereupon terminating the proceedings.

Taunton Electric Lighting Company, Limited.

THE second annual meeting of the shareholders in this company was held at the Castle Hotel, Taunton, on Monday, under the presidency of Mr. W. H. Fowler (chairman), and there was a good attendance, including shareholders from Exeter, where a company has also been formed.

The Chairman moved the adoption of the following report:—The number of shares allotted is 954, on which the sum of £4,750 has been received. The accounts for the year show a profit of

£355 18s. 3d. Your directors recommend that a dividend of 6 per cent. be paid free of income tax. This will take £272 0s. 5d. The balance carried on for a reserve and depreciation account, including the amount from 1887, will be £207 13s. 9d. In addition to the Taunton business, the company has carried out temporary intallations in Bristol, Bath and Exeter. Deputations from various places have visited Taunton during the past year for the purpose of inspecting the company's works and the lighting arrangements of the town, the general testimony being that it is the most successful installation in central station lighting yet carried out in the United Kingdom. The machinery has been maintained in excellent working order, those portions of it which are continuously wearing out being made good and charged to income account. The present engines are rather extravagant in their consumption of fuel; your directors therefore recommend that, as the demand for private lighting is rapidly increasing, engines of the highest possible efficiency should now be put down, using the present engines as duplicate plant only. This will effect a saving of nearly £200 per annum in coal, water, and oil. It is desirable also to largely increase the electrical plant, to enable your directors to cope with the increasing business, and they therefore propose to offer, at par, the remaining share capital of the company. Should the applications for shares exceed the number offered, the present shareholders will receive priority of allotment in proportion to the number of shares they now hold. In doing so, he said it was a very satisfactory thing that at this end of their second year they were able to pay an increased dividend, and at the same time to make proper provision for depreciation of plant, and for any extraordinary expenditure that might come upon them. They had carried forward a sum of £207 13s. 7d., and as the machinery was kept in its highest efficiency he thought they could consider they were fully justified in paying an increased dividend. At the same time it was absolutely necessary to enlarge their plant, and they would be unable to do so unless they had further help from the general public. If others were prepared to back him up, he would put a further sum of £500 in the company, because he was fully satisfied that the thing would be a success, provided they made it large enough to meet the demands of the general public.

Mr. C. E. Lance seconded the adoption of the report.

Mr. H. G. Massingham, the managing director, said the revenue had increased by 45 per cent. during the past year, and he thought there was every probability that next year they would earn a dividend of not less than 7 per cent., for at present they had a large number of customers waiting whom they were unable to supply until they had additional plant. Whereas two years ago they commenced with one dynamo, they now possessed six. He believed it was the most successful installation in England, and they had been very fortunate in not having any accidents.

Mr. Potter, a director, stated that the success of this company was unprecedented in the history of electric lighting in England.

The retiring directors and auditor were re-elected and thanked for their services, and a vote of thanks to the chairman concluded the proceedings.

Cuba Submarine Telegraph Company, Limited.

THE thirty-fifth ordinary general meeting of this company was held at No. 85, Old Broad Street, E.C., on Wednesday, Mr. Joaquin de Mancha, the chairman, presiding.

Mr. James Scott, the secretary, having read the notice convening the meeting,

The Chairman said they brought forward from last year's account £1,195, to which they had added £20,708 from the working of the past six months, which was the worse half of the year. Messages had increased by 3,440 during the six months. The amount received was in excess of the previous six months by £1,860. They now proposed to declare dividends at the rate of 10 per cent. on the preference shares, which would absorb £3,000, and at the rate of 9 per cent. per annum on the ordinary shares. Considering the difficulties to be encountered in the telegraph business, he thought this was a very satisfactory result. No doubt they were aware that the French cable with which they had been threatened so long had now been laid from Venezuela to San Domingo, Hayti, and Cuba. They had done all they could to see that their rights were not trenched upon. Mr. Scott had been to Madrid and Mr. Keith had now gone to Cuba, and every step would be taken to see that they were not interfered with. The only thing he wished to draw particular attention to was the matter of the Cienfuegos-Batabano cable, which was referred to in the report. Cables did not last for ever. That cable had been down a long time, and every now and then little interruptions occurred. While Mr. Keith was in England they consulted him upon the subject, and had engaged a steamer which was going out to take cable for any repairs that might be required. If by any chance there should be a greater injury to the cable than they had anticipated they might have to duplicate the cable. That was why they were always careful to keep the reserve fund as strong as they could. It now stood at £84,000. He concluded by moving the adoption of the report and accounts.

Mr. Alexander Low seconded the motion, which was unanimously agreed to.

The Chairman then moved that the dividends already mentioned, 10 per cent., subject to income tax, on the preference shares, and 9 per cent., free of income tax, on the ordinary shares, be declared.

Mr. Low seconded, and the motion was carried.

The Chairman moved a vote of thanks to the staff both at home and abroad, which was heartily accorded, after which a vote of thanks to the chairman and directors brought the proceedings to an end.

German Union Telegraph and Trust Company, Limited.

THE eighteenth and final ordinary general meeting of the shareholders of this company was held at Winchester House, Old Broad Street, on Wednesday, Sir James Anderson presiding.

Mr. William Payton, secretary, having read the notice convening the meeting,

The Chairman, in moving the adoption of the report and accounts, confessed to some disappointment at the fact that they would be unable to get quite the par value of their shares, as they had expected to do at the meeting in December. Since that time a cable had broken, and they had to repair it at a cost of £7,684. That took off 6s. 8d. from the original shares, and, allowing for the exchange, they would now receive £7 6s., and ultimately £9 9s. 10d. for their shares.

Mr. Erichsen seconded the motion for the adoption of the report, which was carried unanimously.

An extraordinary general meeting was then held, at which the resolutions for the winding up and appointing Sir James Anderson and Mr. William Payton liquidators, which were passed at a previous extraordinary general meeting, were confirmed.

The India-Rubber, Gutta-Percha, and Telegraph Works Company, Limited.

THE directors' report for the year ending December 31st, 1888, states that the annexed accounts show the net profit for the past year to be £57,157 14s. 2d. Adding £9,530 3s. 5d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £45,887 17s. 7d.

The directors recommend the distribution of a dividend of 10s. per share, free of income tax, amounting to £20,800, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving £25,087 17s. 7d. to be carried forward.

The company's general business continues to increase; but competition is as keen as ever, and only a low rate of profit can be made.

The submarine cable work of the year has consisted of several items of small amount. The works are now occupied in the manufacture of about 800 miles for the Eastern and South African Telegraph Company, to be laid in May on the West Coast of Africa, in extension of the West African Telegraph Company's cables manufactured and laid by this company.

The company's works and machinery are in efficient working order.

Telegraph Construction and Maintenance Company, Limited.—Including the interim dividend of 5 per cent., the directors propose to pay 20 per cent. for the past year.

Crompton & Co., Limited.—The directors have declared an interim dividend of 7 per cent. per annum upon the preference shares of this company for the five months ending 31st December last; they have also decided to pay at the same time the 4 per cent. interest to same date upon the amounts paid in full in advance of calls.

London and Provincial Electric Lighting and Power Generating Company, Limited—Mr. Justice Chitty has appointed Mr. Lionel H. Lemon, chartered accountant, official liquidator of this company in place of Mr. W. Lott Grimwade.

TRAFFIC RECEIPTS.

The Cuba Submarine Telegraph Company, Limited. The number of messages passing over the lines of this company during the month of January was 3,922, estimated to produce £5,160, against 4,064 messages, producing £5,366 in the corresponding month of last year. The traffic receipts for the month of October, estimated at £3,900, realised £3,516.

The West India and Panama Telegraph Company, Limited. The estimated receipts for the half-month ended the 31st January are £2,770, as compared with £3,759 in the corresponding period of 1888. The October receipts, estimated at £5,197, realised £5,325.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 1st, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £3,691.

The Direct Spanish Telegraph Company, Limited. The estimated receipts for the month of January were £1,880, against £1,943 in the corresponding period of last year.

The Eastern Telegraph Company, Limited. The receipts for the month of January, 1889, amounted to £63,835, against £56,164 for the corresponding month of last year.

The Eastern Extension, Australasia and China Telegraph Company, Limited. The receipts for the month of January, 1889, amounted to £41,820, against £39,578 in the corresponding month of 1888.

The West Coast of America Telegraph Company, Limited. The gross earnings for the month ending January 31st are £4,125.

The Great Northern Telegraph Company, Limited. The receipts in January, 1889, £22,400; corresponding month, 1888, £21,400; and of 1887, £20,400.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended February 1st amounted to £4,795.

BRIGHTON AND THE ELECTRIC LIGHT.

A SPECIAL meeting of the Brighton Town Council was held last week for the purpose of taking into consideration a report from the General Purposes Committee regarding the application of the Brighton Electric Light Company, Limited, for a Provisional Order under the Electric Lighting Act, 1882 and 1888. They stated that they had carefully considered the questions involved in the application and had also examined the draft of the provisional order and consulted Messrs. Rees and Frere, the Parliamentary agents for the Corporation and the Hon. Reginald Brougham, electrical engineer. The committee found that there were many serious objections to the provisions of the Order, including those authorising the continuance of overhead wires and the system of charging for electricity proposed under plan A of schedule B, which was, the committee were advised, a most unfair and misleading one to the consumer. In their view, however, by far the most serious question for consideration was whether the Council should, under any conditions, consent to another company being empowered to break up the public roads and pavements in the borough, whenever it might suit them to do so, for the purposes of their private speculation. The exercise of such powers by companies was attended with inconvenience and danger to the public and entailed considerable cost upon the Corporation, and the committee thought that any application for such powers by a company should be strenuously opposed by the Council. Under section 27 of the Electric Lighting Act, 1882, provision was made for the compulsory sale to a Local Authority, upon valuation under certain conditions defined in the section, of any undertaking authorised by a Provisional Order or special Act, for the supply of electricity within their jurisdiction, upon notice from the Local Authority given to the undertakers within six months after the expiration of every subsequent period of seven years; but section II. of the Act of 1888 repealed the above-mentioned section of the Act of 1882, and although it enacted the provisions of the former Act with little alteration, except slightly varying the conditions upon which the valuation was to be made, it substituted 42 for 21 years as the first period for which the undertakers were to be free from compulsory sale, and made the subsequent period ten years instead of seven years as in the Act of 1882. If, therefore, the company were permitted to obtain the powers they sought, they would be free to exercise them for 42 years without disturbance, and however desirable the Council might deem it to purchase the undertaking they would be unable to do so, unless the company agreed to sell, and then only upon such terms as the company might be willing to accept. The committee also called attention to various clauses in the two Acts, from which it would be seen that the Act of 1888, whilst it increased the period for which companies were to be free from compulsory sale to local authorities from 21 to 42 years, at the same time made the grant of provisional orders by the Board of Trade to persons or companies subject to the consent of the local authorities (which was not required under the former Act), but reserved to the Board power to dispense with such consent in any case in which they were of opinion that it ought to be dispensed with, and in any such case the Board was required to make a special report, stating the grounds upon which they dispensed with such consent. In 1883 the Corporation themselves applied for and obtained a provisional order authorising them to supply electricity within the borough, but the powers of the Order had not hitherto been exercised in consequence of the uncertainty surrounding the question, and the fear that works established with a view to adopting any particular system of supply would within a short period become useless by the invention of more suitable machinery and appliances and the discovery of more economical means of supplying electricity. Great progress had been made in these directions since the date of the Corporation Order (1883), and the committee were of opinion that the Council might shortly be able to commence the supply of electricity under their powers without incurring serious risk of loss. They learnt that the Corporation of Bradford (who also obtained a provisional order in 1883) had recently laid down mains and were about to commence to supply a small area in their borough at an estimated capital outlay of £20,000. The committee were of opinion that the Council might shortly be able to commence to supply a small area in their borough at an estimated capital outlay of £20,000. The committe were of opinion that the Council should exercise the authority conferred on them by Section I. of the Electric Lighting Act, 1888, and refuse their consent to "The Brighton and Hove Electric Light Supply Order, 1889." They submitted therewith draft objections to the Order prepared by Messrs. Rees and Frere, which they recommended should be adopted and forwarded to the Board of Trade and to the secretary of the company.

Alderman E. MARTIN moved "That the Council refuse their consent to the Brighton and Hove Electric Light Supply Order, 1889, applied for by the Brighton Electric Light Company, Limited, and that the objections to the Order now submitted be and they are hereby approved of and adopted, and that engrossments thereof be forwarded to the Board of Trade and to the secretary of the company." He remarked that when improvements had been made in electric lighting they were prepared to take it up themselves, but it would be obviously very unwise for them to place themselves in the hands of a speculative company. The company wanted overhead wires, which were very objectionable, while it would be equally objectionable if they were allowed to dig up the streets without the Council having any control over them. Several towns had speculated in electric lighting, and had found it a failure, and he did not think they had any right to follow suit. They were, however, he believed, prepared to take the matter into their own hands when the proper time arrived.

Councillor BERRY seconded the motion.

Councillor E. A. DELL opposed, and said that although it was not right for the Council to speculate, he thought they had no right to stand in the way of a company which, if any loss ensued, would have to bear it. The Council gave no encouragement to anybody to invest their money in Brighton, and as soon as people came and said they wanted to invest they cried out "No, take it somewhere else; this is not the place." Let people come to Brighton and spend their money. At Taunton the electric light had been successful, and he thought that cold water ought not to be thrown upon the present scheme. Councillor Dell said that directly a loan of £100,000 was proposed to light the town by electricity the poorer inhabitants would strongly object to put their hands into their pockets to provide what might be termed a luxury for the rich. He did not object to their keeping the lighting in their own hands, however, so long as they did not continue to put off the question from year to year.

Councillor BROADBRIDGE said he should have been inclined to support the company's application but for his objection to overhead wires, and the fact that 42 years was too long a period for which to grant a monopoly.

After further discussion the motion was carried, and the meeting terminated.

ELECTRIC METERS FOR CENTRAL STATIONS.

By Prof. GEORGE FORBES, F.R.S.

(*Concluded from page* 136.)

*Lowrie-Hall Meter.**—I will now say a few words about a meter specially designed for alternating currents, which resembles the Edison meter more than any other. This is the Lowrie-Hall meter. A battery—preferably a secondary battery—is placed on the secondary circuit of a transformer. An electrolytic cell is also placed in the circuit. Now there is no complete circuit through the battery and electrolytic cell except when lamps are in circuit, and it is only then that electro-chemical action can take place. The alternating current does not transfer metal from one plate to another. The whole effect in this way is produced by the battery, which acts as if the alternating current did not exist. The continuous current thus flowing is proportional to the conductivity of the circuit, *i.e.*, to the number of lamps at work. Thus the total number of lamp-hours, or Board of Trade units, is measured by the quantity of metal lost by one plate or gained by the other. This is an extremely novel and ingenious idea. One is inclined to ask how long the battery will stand the alternating current, and whether there is much trouble in charging and replacing the secondary batteries. I am informed that these meters have been successfully at work at Eastbourne for more than a year.

Schallenberger Meter.—A very practical form of meter has lately been brought out by Mr. Schallenberger, electrician to the Westinghouse Company at Pittsburgh, an extremely ingenious and accomplished electrician. It also is intended for use only with alternating currents, and is a very convenient type of meter. It does not require great delicacy of construction, and is not liable to get out of order. The objection to it is that its indications vary with the speed of reversals of the alternating current, and our best governors are not perfect, and our most reliable suppliers of electricity would be tempted to alter its indications by increasing the speed of the engines a little. But the meter remains a beautiful practical instrument, which is doing splendid work in the United States. Mr. Schallenberger † promised to send me one of these meters, but I am sorry to say it has not yet arrived.

Forbes's Windmill Meter.—Some years ago, when I first realised the value of the invention of Messrs. Gaulard and Gibbs, for distributing high-tension currents in the mains and delivering it as low-tension in the houses, I felt that one difficulty in the way of adopting it was the want of a meter for alternating currents. Such a thing did not exist, and I felt certain that the public would never be satisfied with a meter whose indications depended on the speed of reversals. It therefore seemed to me that the heating quality of the currents was the only one which would succeed, and would be equally applicable to continuous and alternating currents. I was fortunate enough to have the kind assistance of Mr. A. Stroh for perfecting the details, and eventually the windmill meter was completed, in which the heat generated in a resistance sets up convection currents in the air, which work a kind of windmill. Here the force is proportional to the square of the current, and the opposing resistance is air friction, which varies as the square of the velocity, so that it was natural to expect that the indications would be accurate, and this was found to be the case.

* This was fully described and illustrated amongst our collection of British Association papers last year. See REVIEW for September 21st, 1888.

† For full details of the Schallenberger meter see the REVIEW for September 28th, 1888.

The windmill which I use is made of a horizontal mica disc, with mica vanes round the edge, inclined at 45°, attached to it by small pieces of pith. It has a hole in the centre, in which is fitted a thin paper cone, which has at its apex an aluminium cone, supporting a steel pinion with a ruby cup in its centre. This cup rests on a needle point, and the pinion works into the train of wheels which does the counting.

When this meter was perfected, it seemed that the English demand was not great, and it was best to modify it to suit the American market. I went to America to find out exactly what was wanted, and altered the instrument accordingly. The chief objection raised to it was the difficulty of mailing it, and a fear that it was too delicate. Consequently I strengthened some of the parts, reduced the sharpness of the needle point, and provided a metallic case in place of a glass shade. A considerable number have been sent across the Atlantic in both directions by the ordinary channels, without any injury. On arrival, all that has to be done is to release a spring, so as to free the windmill and let it play upon the needle point. The electric resistance of the conductor has also been objected to. This I was able to correct by altering the form of the conductor in which the heat is produced. Its resistance is now $\frac{1}{100}$th of an ohm, and Mr. Schallenberger, after testing, at Pittsburgh, a batch which were sent direct from the workshop, without any adjustment, wrote to me, saying that they are quite accurate, and that the fall of voltage, due to resistance, is quite low enough, and that they were put to work on the regular commercial circuits. Mr. Westinghouse has acquired the rights for America, and is now manufacturing them at Pittsburgh. It is the only meter which he supplies for motors and continuous currents, and it also works equally well with alternating currents, of any speed of alternation. For alternating currents he has hitherto used the Schallenberger meter. The range of my meter in the American pattern is about 12 to 15-fold, about the same as the Schallenberger meter. When I use more delicate wheel-work, the range is greater.

I need hardly say that the perfecting of such a meter has led to innumerable experiments. Trials have also been made of a variety of other means of utilising the heat. I would not be doing my audience justice if I did not show them one other type which I have constructed, which is very simple and effective, but which has one slight defect, viz., that it is not easy to manufacture in numbers all exactly alike. It consists of a wire conductor covered with cotton, which absorbs alcohol from a reservoir. The electric current being passed through the wire heats it and evaporates the liquid, which is condensed in a tube, where it is measured. This quantity is an exact measure of the quantity of electricity which has passed through. This instrument has not been used on commercial circuits.

Since the beginning of September, 1887,* when I first exhibited the mill-wheel meter, an enormous number of patents for meters have been taken out, but I think I have described all that have as yet proved themselves to be of practical value. Each of the meters I have described has its merits, and all are doing good work in central station distribution.

DISCUSSION.

Mr. R. E. CROMPTON said he had had some practical experience with the Aron meter, but it had been principally through a third party—Mr. Miller, who could have spoken with much more authority as to its performance. They had at first enormous trouble with it, but were eventually successful, and it was through Mr. Miller that many of the improvements had been made. He had recently spent some time in Berlin, and found that they were thoroughly satisfied with that meter, but he should say that it only registered the current supplied to incandescent lamps, whereas the success of the Berlin station depended on arc lamps, which formed about three-fifths of the whole, and they were charged mostly by contract. At Kensington they had never sold current otherwise than by meter, in which he believed they stood alone. At Liverpool, however, there was a central station which worked largely by meter, and by one which had not been mentioned, viz., the Chamberlain and Hookham, which, he was told, had been working there for some weeks, and proved as accurate as the Aron, and was in some points superior, though he did not know the particulars. He could endorse what had been said about the use of the Edison meter in America. He believed no meter had been more aspersed, but at the same time it had done infinitely more real work than any other, and it had been very unwisely neglected in this country. At the time Mr. Ferranti was bringing out his meter, Mr. Kapp and himself were experimenting on exactly similar lines, but Mr. Ferranti was a few days earlier in applying for his patent. With regard to lamps, if Prof. Forbes had had practical experience in lighting private houses he thought he would advocate 8 candle-power lamps, because we had to compete with gas and keep down the annual bill. The greater part of the expense of lighting was incurred for passages, staircases, and so on, and for this purpose a unit a little over 8 candles answered extremely well. Every one who saw the so-called 16-candle lamps worked at the volts at which they were sent out by the Edison-Swan Company admitted there was a great waste of light when used in such situations. These lamps originally yielded 18 candles, or more, but since the improvement in the manufacture of the lamps they had been able to work them slightly in excess of what they were marked. Those marked 8 candles and 97 volts could be worked at 102, and yielded about 11 candles when new, and when quite old the original 8. Customers who could buy the larger lamps if they liked preferred the smaller ones, and more than three-fourths of those in use were the smaller unit. This was not so in shops, clubs, or hotels, where larger lamps were more satisfactory; but to make the electric light spread rapidly and not frighten the people by the cost the smaller lamps should be encouraged. He greatly admired the magnificence of the Berlin central station, but it was very costly, and he thought the same result could be obtained in England for very much less money.

Prof. AYRTON, F.R.S., after paying a tribute to the modesty displayed in the paper, which he would endeavour to emulate, said he should like to break a lance with Prof. Forbes on the old dispute as to whether electricity should be charged by quantity or by energy. It seemed to him that people were somewhat influenced by the meters they had to supply, and naturally liked people to pay for a thing the meter would measure rather than that the meter should measure the thing they ought to pay for. No doubt if it were possible to maintain a constant potential difference between the supply mains, the total quantity supplied in a given time was all that need be considered; but this constant difference of potential was not maintained. Prof. Forbes admitted there was a 2½ per cent. variation; but that amount of variation in the volts meant a very great difference in the amount of light, which was really what the customer thought about. He did not care about volts, watts, or anything else; he bought light, and wanted a meter to measure what he was paying for. A variation of 2½ per cent. in volts—and it was more in practice—meant a considerable drop in the light, which was about proportional to the cube of the volts, minus a constant, as shown by the experiments made by Prof. Perry and himself on several types of incandescent lamps some years ago. The other day he was in St. James's Hall during an afternoon performance, when the light went down so much that the gas had to be turned on full. Supposing you were paying by current, you would pay not much less than if the right voltage were maintained between the terminals, and if a few more lamps were turned on the total current would be the same; but the light obtained would be nothing near the same, so that during that half hour the customer would be paying the full gas bill and the full electric light bill as well. In fact, so far from employing a meter which took no notice of any variation in the volts, as was advocated by Prof. Forbes, he was not sure but that the meter ought to take into account some higher power than the first of the volts, so that it would measure, perhaps, the integral of the product of the current into the square of the volts, seeing that the light fell so rapidly with the fall in the volts; but whether this was done or not, they certainly ought not, he thought, to be satisfied to neglect variations of even the first power of the volts on the indications of the meter. There was one point about the simplicity of testing which Prof. Forbes had not referred to, which existed in retarded clock meters, but in no others. During the time you were not using the electricity you could check the accuracy of such a meter, because the clock, which was simply retarded when the current was supplied, was not retarded at all when there was no current passing, and you could therefore compare the going of the meter during the day with any respectable watch, and with which it ought to keep time. No one of the other meters could be tested in that way. A way Prof. Perry and himself suggested some years ago of getting over the possibility of cheating in an ergmeter for measuring the product of the current into the volts had a pendulum wound with wire, the wire round the pendulum being a shunt to the main circuit. By putting a magnet near the clock the consumer might prevent it being retarded so much, but it was proposed to occasionally reverse the current in the whole system, which could easily be arranged, and the result would be that any one who tried to cheat by the use of a magnet would be as likely to increase his bill as to lower it. He agreed in the objection which had been raised to contacts in meters, but there was one meter patented some years ago by his colleague and himself which was not open to the same objection, though it had two contacts. It was a motor, the field magnets of which were wound with thick wire, and there was a continuous circuit through them—no make or break at all. The rotating armature was wound with very fine wire of high resistance, and there were two brushes to lead the shunt current through the armature, and any changes in the resistance of the contact of these brushes made very little difference in the total resistance of the shunt circuit. There were no brushes in the direct circuit, and any slight amount of dirt which in time accumulated under the brushes in the shunt circuit introduced very little error. He ought to mention in passing that the ergmeter had no defect in that it measured what the customer ought to pay for. If the supplier could keep a constant difference of potential between the terminals, then the ergmeter became a coulomb meter, but if the supply were variable the ergmeter checked the supplier if he did what he ought not to. He thought Prof. Forbes must be in error in speaking of fluid friction being proportional to the square of the velocity; with small velocities the retardation was not proportional to the square but to the first power of the velocity; with a velocity such as existed in the beautiful instruments on the table, the vanes were not moving much faster than the needle in a ballistic galvanometer, and the damping correction of that instrument was, as was well known, on the principle that the retardation did not vary with the square of the velocity. Indeed, their own motor ergmeter, in which fluid friction was used, and which was patented in 1882, was based on the principle that the

* Prof. Forbes's meter was illustrated in the REVIEW for September 9th and September 23rd, 1887.

friction was proportional to the first power of the velocity. There they wanted to measure the time integral of the product of the current passing through the field magnet, and the current passing through the armature, which integral was directly proportional to the energy. The force-causing motion was proportional to the product of the two currents, and if it were assumed that for slow velocities fluid friction was proportional to the velocity, the distances travelled through by the armature would be proportional to the watt seconds, or, in other words, to the total energy supplied. If the retardation were proportional to the square of the velocity, the meter would not have worked satisfactorily. While on the subject of fluid friction, he would allude to one defect with all these motor meters which had prevented them improving and introducing their own motor ergmeter. You wanted simpler fluid friction, not solid friction. You must not have the friction of mechanism, and therefore it was necessary to reduce the dials and recording mechanism to such very minute dimensions, and to make them so delicate, that great difficulty was introduced. That was the great difficulty with the Ferranti meter; if he had no recording mechanism his meter would have been perfect; but the friction introduced by the dial mechanism was a great difficulty, and he understood that though Mr. Ferranti had many thousand lamps at work where the current was measured by these meters, he was not yet satisfied with them, and was sending to America for machinery to make more delicate dial mechanism. The retarded clock-meter had no such defect, as the mechanism was not driven by the current. In one sense it was a defect to have to introduce another motive power, but by so doing you got over the difficulty he had mentioned. The friction of the mechanism introduced no more inaccuracy than was to be found in a good chronometer. With a motor meter it was absolutely necessary to reduce the dial mechanism to the smallest possible dimensions. His colleague and himself owed a debt of gratitude to Dr. Aron for the way in which he had carried out the principle they had put forward, and, as his agent had wisely commercially acknowledged their claims to priority, there was perfect accord. He was a little surprised to hear of the success of the Lowrie-Hall meter, which was based on the assumption that the alternate current, when passing through a voltameter or an electrolytic cell, produced no decomposition, but this had been found, from the experiments made by his students, an extremely difficult condition to arrive at. It meant that if you sent an alternate current through a voltameter, no gas would be produced; but, in fact, you could easily get a considerable amount produced, and you could get copper deposited with a current making many thousand alternations per minute. He was much surprised, and at the same time much pleased, to hear that this difficulty had been successfully surmounted. At the end of the paper, Prof. Forbes had briefly described a meter which gave its indications by means of the evaporation of alcohol. A meter on the same principle was made at the beginning of last year, by Mrs. Ayrton, mainly by her own experiments at home, though tests upon it had been subsequently made by her at the Central Institution. In that case, water was evaporated by the passage of the current; the water fell through a tube, and, according to her design, worked a recording mechanism, and was finally carried back to the reservoir to be re-evaporated. He had nothing to do with the invention himself, and had, in fact, rather discouraged it, in consequence of the difficulties of such an investigation. He, therefore, now penitently desired to place her meter on record.

Prof. FORBES, in reply, said he was very sorry Mr. Miller had not been present to give his practical experience, but he understoood that at Berlin the single clock-meter was found more successful of the two types of Aron meter. He was very sorry there had been any meter which had been successfully employed in central stations which he had not described. He was aware that Messrs. Chamberlain and Hookham had devised one, but did not know it had been in practical work, and he should make it a point to learn more about it. Since Prof. Ayrton had expressed a desire to break a lance with him on certain points, he should be quite willing to discuss the point in a few sentences. Prof. Ayrton tried to reduce his proposition to an absurdity; and he would endeavour to do the same with what Prof. Ayrton had said. It was intimated that those who made meters did not make them to satisfy the wants of the customer, but tried to make the wants of the customer meet the performance of the meter. The customer wanted to measure the quantity of light, which was proportional to the cube of the volts, and there was no doubt about it, according to Prof. Ayrton, the erg was the proper thing to measure, since this is what his meter measures—whilst he (Prof. Forbes) said the coulomb was the thing to measure—the total quantity of current passing through. He said so. When the lamps were burning down very low, it was a great shame the customer should be charged almost as much as when they were burning brightly. Now, supposing he were supplied by meter, and charged by ergs, by the volts multiplied by ampères. Those who supplied the current would want to send a greater pressure through the lamps than the customer wanted, and so break them down, and the customer then would not only be injured by having his lamp destroyed, but insulted by being asked to pay more in his meter account for this. He thanked Prof. Ayrton for his information about another inventor who had been working on the same line as himself; a great many had tried evaporation, but he had not seen one which made the results proportional to the current going through the meter. With regard to the cost of meters, he had very little information. In America the idea was that they ought to cost about £1 to manufacture, and sell at about double that price, but he did not think they would come down to that in this country. They would probably sell for from £4 or £5 up to £18 or £20.

The CHAIRMAN, in proposing a vote of thanks to Prof. Forbes, said it was quite true that he felt it extremely depressing to walk through the dull and dismal streets of London after coming from New York, which was brilliantly lighted by electricity; but on hearing such papers as this, he felt that there was a possibility of that depression being removed. He believed we were on the eve of a boom in electricity. Only yesterday the Commissioners of Sewers of the City of London decided on issuing a specification and inviting tenders for lighting the City, and it was to be hoped that before the end of the year, Fleet Street, Ludgate Hill, and Cheapside would even surpass the famous Unter den Linden. With regard to 16 or 8-candle lamps, he agreed with Mr. Crompton that when Prof. Forbes had had more practical experience of the fitting up of private houses, he would come to the same conclusion as Mr. Crompton and others, that the proper candle-power to use in houses was 8 or 10. In a large hall it would be absurd to use such lamps, but there really ought to be a new system introduced, as Mr. Shoolbred had said, of speaking of lamps not by candle-power, but of so many watts. The standard lamp in his practice was one of 50 watts. If people in the Colonies or abroad sent home indents for an electric installation for so many thousand lamps, no one would know what they wanted; but if they sent for so many lamps of so many watts, they would know exactly what to send, the proper dynamo to give the current, and the batteries required to maintain it. Throughout the Post Office they commenced with 16-candle lamps, but found that 10-candle gave all the light required. The real question was not so much the power of the lamp as the proper distribution of the light. When you had decided on the amount of light required to read, or write, or to do any particular work, it was easy to calculate whether the lamp should consume 30, 50, or 100 watts, because that simply depended on the position in which it was placed.

The vote of thanks was carried unanimously, and the meeting was adjourned.

Mr. A. W. SWAN writes:—Prof. Forbes has given us an admirable *resumé* of the present state of knowledge of electric current meters, or at least such of them as have come into practical use. His lecture occurs at an opportune moment, when large projects are afoot for the distribution of electric current from central stations, and when, therefore, electric meters are an imperative necessity.

Meanwhile, although we have got several kinds of meters, all of them reflecting the highest credit on the ingenuity of the inventors, if I single out any one of these as especially deserving of mention for felicity of idea, and exquisite development of the idea, I should certainly have to mention the exceedingly beautiful meter of Prof. Forbes.

I do not remember how many it possesses of the 13 qualifications which Prof. Forbes told us should be possessed by an ideal meter, but certainly in his they will count up to a goodly number. I believe I am right in thinking that it was the first of those meters which measure both continuous and alternating currents. How surprisingly the supposed disabilities of alternating currents have melted away in the presence of that all-solving sun—necessity. Now we have not only motor meters, but also electrolytic meters for alternating currents. Truly, "All precious things discovered late, to those who seek them issue forth;" and at last I suppose we shall have our ideal meter.

The things most lacking in the best of the meters shown to-night are want of range and want of simplicity. Range and simplicity were two of Prof. Forbes's 13 points. To put the first of these into figures, I should say that the range should be at least 1 to 100, instead of 1 to 15 or 20, the range of those meters which so far have the greatest number of the 13 points. In respect of simplicity, and consequently of cost, I think all the motor meters leave much to be desired.

The experimental meter which Prof. Forbes showed us last, if he can conquer the difficulties of detail that stand in the way of its being made a practical instrument, as he has conquered the seemingly as great difficulties of detail in the case of his windmill meter, would, I think, score most of the 13 points. Certainly it would have the very great merit of simplicity and wide range, and I earnestly hope that he will persist in the endeavour to perfect it.

PROCEEDINGS OF SOCIETIES.

City and Guilds of London Institute Old Students' Association.

(*Continued from page* 132.)

We have now to determine the values of Z_a, N t, C_a, and r.

C_a will usually be given us by the condition of supply and the horse-power required.

Z_a can be determined from the equation

$$Z_a = 2\,a\,b\,z \qquad (\delta)$$

where z = lines per square inch, a = depth of core in inches, b = the length of armature *less the insulation* in inches.

Experience alone can tell us the best shape and size of armature

core, but since the total cross-section ($= 2\,a\,b$) is known no great difficulty presents itself. The depth of core will be mainly determined by the style of winding and the value of T. For a small torque a small armature and a large number of revolutions will be chosen; for a large torque a large, slow-speed armature is required. It will be necessary to note that a large cylinder or ring armature of short length is equivalent to a long drum of smaller diameter.

Then, assuming that the core be chosen, a, b and r are known. It only remains to substitute these values in (γ) and solve for N, t. If the quantities are properly chosen N, t will have such a value that for a suitable current density the depth of winding will be about 10 per cent. of the core radius for cylinders and 15 per cent. for drums.

If the value of N, t be not a rational one the dimensions of the core must be altered. A few trials will illustrate this important part of the design, but practice alone can give ease and certainty.

In actual practice the matter is much simplified by previous experience and by fixed sizes of cores. It is then customary to select a wire to suit the current given, and to vary the speed so as to make the magnetic density suitable for the work. This is the crucial part of the whole thing. In others words, the motor is designed to give the required torque at a certain part of the characteristic. This point varies with the shape of the curve and with the conditions of work expected. My meaning will be more easily seen when the field magnets have been discussed.

The best relative dimensions of armature and field cores is an open question. This is apparent from what has already been said. It depends entirely on the object aimed at. If weight efficiency be the desideratum, the armature *must* be relatively powerful, and the cross section of the cores may be made equal, allowing, of course, for the different permeabilities of the iron used. But if cheapness be the principal object, then a heavy field and a small armature are necessary. Speaking generally, the field strength has to be *relatively* greater as the size of the machine is increased.

The design of the motor field presents some considerable difficulty to the student. There are so many shapes and forms in vogue, and the same end seems to be attained with such opposite forms. With few exceptions, too, even old established firms are continually changing their patterns, often with no apparent effect other than a weakening of the public confidence, and a considerable needless expense. Indeed, the engineering draughtsman seems to be at his wit's end to bring out a new design. Yet there is really no ambiguity on the subject. Text books tell us the best form of magnet is that, *ceteris paribus*, which offers the least magnetic resistance, with a maximum cross section and a minimum perimeter. Theory then points to a horseshoe magnet, of circular form and round cross section. Difficulties of construction, however, render this ideal form too costly, and the matter has to be compromised. It is to this endeavour to balance the advantages of theoretical indication with the necessities of engineering that we owe the numerous types of fields.

The design of the field is, however, not so important with the motor as with the dynamo, and a little consideration will enable the student to determine suitable proportions.

In the first place the field has to supply a certain number of lines of force to the armature, or is expected to form poles of such strength that, in conjunction with those found in the armature, the necessary torque will be obtained. If gross weight be neglected, and a minimum expenditure of copper be desired, the single horseshoe is chosen. Such machines are common enough, and may be made vertical, horizontal, or inverted. The two first types are the better, since the leakage is less. If a light-weight machine be required, even at the expense of copper, then double horshoe magnets are used. This type involves twice the number of ampère turns to give the same strength of pole as the single magnet does; but yet it has considerable advantages. The resultant magnetic field is likely to be more uniform, and less trouble is given by the brushes as a rule. If the armature be of a large diameter—say more than 24 inches—it is better to have a four-pole machine, although the ampère turns will be double that required with a double magnet, and four times that with a single one, if the same value of Z_a be taken. The Oerlikon dynamos, for the reduction of refractory ores, are made with six poles, and no doubt a more even distribution of magnetism is gained.

Having selected the form of magnet the question of length and cross section of limb arises. Here the criterion is simply sufficient space to wind the wire necessary to give the desired strength of poles and area enough to carry the magnetic flux required.

Here the student finds the first real difficulty. Let us review the position. We know the E.M.F. of supply or the allowed number of volts; the current is also approximately known from the B.H.P. and the assumed efficiency of conversion. The torque of the motor has been determined and expressed in terms of the magnetic flux through the armature iron, the effective cross section, and the number of turns of wire; the dimensions and shape of the core are also agreed upon. So far it is a physical certainty. The problem now, primarily, is to design a field magnet which, in conjunction with the armature, will give the required number of lines in the armature core. This is strictly all that is necessary. The question of economy of material and labour spent in the building of the field magnets cannot be discussed here.

The magnetic flux in the magnets, to give a particular value of Z_a, I believe to be unattainable by direct calculation. Let Z_1 be the total lines induced at S in a single horseshoe magnet, and assume the lines to pass through the yoke, Y, and enter the armature at N. The leakage which occurs all along the windings, and on the neutral part or yoke, reduces the value of Z_1 to, say, Z_2. But Z_2 is still further lessened by leakage of lines from N to S outside of the iron or copper of the armature, and the effective number of lines is reduced to, say, Z_3. Now, the ratio of $Z_1 : Z_2 : Z_3$ will vary according to the shape of iron, the length of cores, the contour of the winding, and the average density of magnetism. The problem is already sufficiently complex, but yet this is not all. We have yet to take into account the useful

number of lines induced in the armature by its own windings = say, Z_4. This quantity is usually ignored in text books, but I know from a large number of experiments that, if we wish to be accurate in our treatment of the subject, this factor must not be neglected. I cannot go into figures, but the importance of the motor armature, considered as an independent source of magnetism, may be understood from the following considerations:—

Take a large series machine designed as a dynamo, having a relatively powerful field and weak armature. Let this be run at such a speed and output that the top of the straight part of the characteristic is just reached. Observe the speed, current, and terminal E.M.F. Then drive it as a motor, using the same number of volts on the terminals, and load the brake till the same value of the current is attained. The speed will usually, I think, be found to be nearly as great as that required as a dynamo.

Next take a smaller machine, designed as a motor, *i.e.*, one with a relatively weak field, &c., and repeat the experiment. It will probably be found that for the same values of current and terminal E.M.F. the motor speed will be considerably *lower*.

This variation in the two speeds is due partly to the lead required in different machines when run as dynamos or motors, and also largely to the relative importance of the armature magnetism. Two simple equations will assist the study of the problem. Neglecting friction, let

E_d be the *total* internal E.M.F. of the dynamo.
E_m the *effective* internal E.M.F. of the motor.
E_T be the terminal E.M.F. both of dynamo and motor.
C R be the volts lost over the internal resistance of the machine.
L_d be the value of the reactions of the dynamo armature.
L_m be the value of the reactions of the motor armature.

It will be necessary to note that L_d and L_m will vary with the lead required.

For the dynamo we have—

$$E_d = E_T + (C\,R + L_d) \qquad \text{(I.)}$$

For the motor we have—

$$\frac{\text{B.H.P.}\ 746}{c} = E_m = E - (C\,R + L_m) \qquad \text{(II.)}$$

Now, the speed of the motor varies as E_m, and the speed of the dynamo varies as E_d. It follows, then, that the motor speed should be *less* than the dynamo by a quantity proportional to $(C\,R + L_d) + (C\,R + L_m) = 2\,C\,R + L_d + L_m$. If the speed of the motor be *greater* than that given by these equations, L_m, the only quantity that can possibly be varied, must be a factor of importance, and, moreover, of *negative sign*. This means that, in the motor, the armature adds magnetism to the resultant field, and thus increases the value of E_m, and consequently raises the speed. In the limit $L_m = C\,R$ and $E_T = E_m$—*see* (II.) Even if these values were possible in practice, E_m would be still less than E_d; so that the relative values of the speeds can only be seen by examination of the ratios $\frac{E_m}{n_m}$ and $\frac{E\,d}{n_d}$. It will be found with all normal machines that $\frac{E_m}{n_m}$ is less than $\frac{E\,d}{n_d}$. One must not confound the question of efficiency with these experiments. The efficiency of a dynamo for a given E.M.F. and current varies *inversely* as the speed, for the torque is clearly proportional to some function of the current, and is nearly independent of speed. The motor efficiency for the same electrical constants varies *directly* as the speed. In fact, we endeavour to make the dynamo speed a minimum and the motor a maximum.

In the first experiment, say in a large Edison-Hopkinson dynamo, the efficiency either as dynamo or motor will not differ much, but I should expect the motor to give the better result by a small percentage. The influence of the armature is relatively small, and the lead very little. The only objection to the machine considered as a motor is the weight, and consequently, increased cost of material for a given output.

In the second experiment the armature is large compared with the field. Hence, the lead as a dynamo will be great—probably 30° at least in a positive direction; as a motor the lead, if any at all, will be much less, perhaps 5° in the negative direction. The machine will be inefficient as a dynamo, and require a high speed; but as a motor it will be *much more* efficient, though the speed

will not be so great as that required for the dynamo. The second machine will be a good motor, efficient, light, and cheap.

This explanation is very rough, but it will help to explain the reason for considering the armature as an independent magnet in motor design. The Oerlikon plant, described in the technical press some six months ago, illustrates the point. The dynamo and motor have armatures identical both as regards the mass and distribution of iron and copper; but the motor field has 7 per cent. less copper and iron than the dynamo, and I know of many installations where proportionately much smaller motor fields are used with advantage.

Many attempts have been made to predetermine the characteristic of dynamos and motors; yet the best seem to be but approximations. From what has already been said it follows that the difficulty only lies with the number of lines of force in the field. This quantity is indeterminate, chiefly because we have no magnetic insulator. We can get the characteristic of the iron of both field and armature, and we know the resistance of the air space. But we do not know and cannot as yet predetermine by calculation the loss of magnetism which will take place over a new type of machine. Mr. Kapp has shown that this leakage is a function of linear dimensions of the machine, and hence varies with every type; indeed, no matter how small the alteration in design the value of the lost magnetism is changed. Practically this presents no difficulty, as only a few types obtain with most firms, and a few simple experiments will determine the number of ampère turns to give any desired result.

Dr. Hopkinson and Mr. Kapp were, perhaps, the first to move in this direction of calculating the ampère turns required in the field to give a definite magnetic flux in the armature. Both methods are well known, but a brief reference will assist us to follow the subject. Mr. Kapp started from a geometrical treatment of the design, and assumed the magnetic resistance of iron to be expressed by a law similar to that of Ohm, and the saturation effect was assumed to follow a tangent function. I have used the Kapp formulæ for many machines, both dynamos and motors; indeed, I think I was probably the first to apply them to motors; but the results are not satisfactory, particularly with large machines. The equations do not take into consideration the leakage in a sufficiently accurate manner, and the ampère turns have to be increased from 25 per cent. to 100 per cent. above the value given by calculation. The characteristic thus obtained usually rises too slowly, and after cutting the real curve about the point of half-saturation of the field magnet, does not fall sufficiently rapidly. My experience, I believe, is fairly well borne out by other users of the Kapp formulæ.

Hopkinson starts on a different basis. He determines experimentally the curves of saturation of both field and armature iron, and expresses the magnetic flux in terms of absolute magnetising force (4π S i) per centimetre length of core. The specific resistance of air is also determined by experiment. So far this is perfectly safe ground. But the characteristic of the machine itself is the summation of the curves of the field and armature iron and the air space, modified by the leakage and the reactions of the armature. Hopkinson has now to resort to experiment to find the magnitude of these disturbing influences, and a good deal of approximation or experimenting is required; indeed, the method is not applicable to a new type of machine without considerable knowledge of the subject.

Prof. Silvanus Thompson, in the third edition of "Dynamo-Electric Machinery," gives a method combining both Hopkinson's curves and Frölich's equation:—

$$N = N_1 \frac{S\,i}{S\,i + (S\,i)_1}.$$

N = maximum number of lines in field magnet.
N_1 = lines in field magnets to give the diacritical value.
$S\,i$ = ampère turns to give N.
$S\,i_1$ = ampère turns to give N_1.

But this, again, demands an experimental determination of the leakage coefficient, and does not seem to me to advance the subject much.

Mr. Esson employs a modification of Dr. Hopkinson's method. Using the saturation curves of the iron and specific resistance of the air as his starting points, and selecting a definite value of Z_a, he determines the number of ampère turns per centimetre of magnet core to give this value in the armature, correcting for leakage and self-induction. With a known type of machine this method presents great advantages, for the field winding is given by simple reference to the curves.

Fortunately for us practical men there is no pressing need of an exact mathematical solution. With a known type of field, machines of any output can be designed with certainty from previous experience, and easy applications of the rule of three.

It may be noted that the slope of the characteristic is mainly determined by the magnetic resistance of the air gap. The curves of the field and armature iron do not largely affect the general shape till the diacritical points of either be reached. If the field be so crowded with wire that this point be passed, then the characteristic of the machine will bend rapidly.

Before leaving this part of the subject, I will briefly examine the question of pole pieces.

Judging from the variety of shapes of polar extensions obtaining in machines in the market to-day there seems to be no little ambiguity on the subject. Some makers use long poles, extending over nearly 160 degrees of the armature periphery. Others cover 90 degrees to 100 degrees. Some machines are to be found with long, thin, sharp extensions, whilst some have short, thick, and rounded ends. Each in its way accomplishes a particular end, but only want of knowledge could lead to the extreme proportions sometimes met with. This variety of dimensions in the pole pieces and extensions arises from an attempted compromise between theory and simplicity of design.

(To be continued.)

[Mr. Snell asks us to amend the equation appearing in our last issue as follows:—

$$T = K \frac{Ca\ Nt\ Za}{2\pi} \qquad (7)$$

where K_1 is a constant and Za is measured in Kapp lines.]

Physical Society, January 26th, 1889.

Prof. FULLER, F.R.S., in the Chair.

A "Note on a Relation between Magnetisation and Speed in a Dynamo Machine" was read by Dr. S. P. THOMPSON. In a note presented to the Society in June last, it was shown that $\Sigma\rho \cdot \Sigma R = 4\pi n c s$ where $\Sigma\rho$ and ΣR are the magnetic and electric resistances respectively, n = speed, and c and s the numbers of armature and field windings. By writing the equation in the form $\frac{4\pi c s}{\Sigma R} = \frac{\Sigma\rho}{n}$ it is seen that *when the electric resistance is maintained constant, the magnetic resistance is proportional to speed.*

Prof. HERROUN read selections from a paper "On the Divergence of Electromotive Forces from Thermo-chemical Data." The fact that the electromotive forces of voltaic cells do not always coincide with calculated values has not hitherto received a satisfactory explanation, and this paper describes an experimental research bearing on the question. Several suggested explanations are given. In some cells the anticipated chemical changes do not occur, and some metals become coated with oxide or subsalts; others are affected by dissolved gases, and the hydration or solution of the salts formed may supplement or diminish the E.M.F. of a cell, as well as the absorption or evolution of sensible heat. The question of absorption and evolution of heat is the one chiefly dealt with. If such actions do take place, the total heat evolved by passing a definite current through the cell must depend on the direction of the current, and by enclosing the cell in a calorimeter the difference should be detected.

The total heat developed by a current, c, in t seconds is $= \frac{c^2 r t \mp e c t}{J}$ where r is the resistance of the cell and e the divergence of the observed from the calculated E.M.F., the − or + sign depending on the direction of the current. In the case of mercury cells which are usually said to give about half a volt excess E.M.F., the heat was found to be independent of the direction of the current. The heats of formation of mercury salts were then re-investigated, and the results showed that Julius Thomson's numbers (the ones usually accepted) were greatly in excess of the true values. This accounts for the difference between the observed E.M.Fs., and those calculated from Thomson's numbers. A copper-silver nitrate cell was tested in the calorimeter, and the reversible heat effect agreed closely with that deduced from the "thermo-voltaic constant," or divergence of observed from calculated E.M.F. Other experiments on tin, lead, nickel, iron, and cadmium cells are described, and the chief conclusions arrived at are:—1. The primary factor in determining the E.M.F. of a voltaic cell is the relative heat of formation of the anhydrous salts of the two metals employed. 2. That this E.M.F. may set up chemical changes of a different direction and character from those predicable from the heat of formation of the dissolved salts. 3. That the E.M.F. set up by (1) may be and usually is supplemented by the energy due to the hydration or solution of the solid salts, and may have values which accord with the heat of formation of the dissolved salts. The absorption or evolution of sensible heat depends primarily on the attraction between the salts and water, combined with the heat of solution, and finally the author states that the E.M.F. of a cell gives a more accurate measurement of chemical affinity than data derived from calorimetric observations.

CORRESPONDENCE.

Designing Electro-Motors.

In your issue of the 25th ult. you mention some experiments made by you on a Bürgin dynamo with results apparently contradicting those of mine, to which you also refer.

Permit me to remind you that in my article on "Electro-motors and Generators" reprinted in the ELECTRICAL REVIEW in 1886 (Vol. XIX., page 447), was given the table below which shows fully the results obtained from a Bürgin dynamo driven as both motor and generator. My experiments, as then stated, were undertaken with the view of ascertaining whether similar results were obtained from other

machines. I found (see article) that the difference between $V_1 + C R$ and $V_2 - C R$ might be neglected in smooth core ring armatures working at about the ordinary degree of saturation, while in the Bürgin this was far from being the case. The reason is not quite apparent, but I contend now, as I did then, that experiments with the irregularly formed armature of a Bürgin machine can afford no clue regarding the reactions in an ordinary ring core.

TABLE III.

Bürgin Machine, No. 333 B (*Series*).

Revs. per min.	V_1	V_2	C	$V_1 + C R$	$V_2 - C R$	Diff.
500	16	116	14·0	64·67	67·40	2·73
640	36	130	12·5	79·46	86·54	7·08
720	60	98	4·25	74·11	83·89	9·78
780	59	138	10·0	93·77	103·23	9·46
830	66	142	9·0	97·30	110·70	13·4
840	72	118	4·5	87·00	103·00	16·0
860	70	144	8·75	100·40	113·60	13·2
1100	104	152	4·75	119·77	136·23	16·46
1180	114	164	5·0	130·60	147·40	17·20

V_1 = volts at terminals as a dynamo. V_2 = volts at terminals as a motor = C = current, R = resistance.

W. B. Esson.

London, *February 3rd*, 1889.

In the discussion which followed the reading of Mr. Snell's paper on the design of electric motors, at the Old Students' Association, I made some remarks which I find reported in one of the technical journals in so curtailed and disconnected a manner (owing, no doubt, to my indistinct way of expressing myself) that I shall feel obliged if you can find space for the following corrections and elucidations of what I said :—

I pointed out that we were well justified to look upon the electric motor and its application in our industrial, social and domestic life, as the most important field for the employment of the energies, skill and inventive powers of electrical engineers ; and that even in the near future—although still labouring under many difficulties and disadvantages—we shall find that "Electric-Motor-Engineering" will absorb our attention to an important extent, as compared with "Electric Light" and other branches of electrical engineering.

As an example, I referred to the employment of electric motors in lieu of horses in our streets, to give us a purer atmosphere to breathe ; for, in spite of every means employed, the effluvia, rising from the pavement during a summer's evening, after a day's horse-traffic, must convince the most credulous that the inhalation of such odours cannot but have a baneful effect upon the inhabitants of the Metropolis.

But, irrespective of the advantages as regards sanitation and convenience, the employment of electric motors will increase to an unexpected extent the moment we shall have discovered a cheaper means of producing electricity—say, by the oxydation at a low temperature of coal, or any other substance cheaper than zinc. This may appear at first sight visionary ; but no engineer or scientist, who is acquainted with the history of the physical and chemical sciences, and with the development of our technical industries, will take upon himself to deny the possibility of such an achievement in electrical engineering ; and, in view of such a possibility, the electric motor deserves our fullest attention.

I then expressed the pleasure with which I had listened to Mr. Snell's paper, and the great diffidence with which I spoke in presence of one who had undoubtedly, in his position as electrician to Messrs. Immisch & Co., the greatest experience about electric motors in England ; and, although, on the whole, I could but express my admiration and gratification at the paper, yet I could not help disagreeing with Mr. Snell on one important point ; I should have to speak as a "Heterodox"—as which, Prof. Ayrton had just then said, he was looked upon, when he advanced his motor theory before the then Society of Telegraph Engineers in 1881. (?)

I ventured to express it as my conviction that the development of the electric motor had been hampered by its relation to the electric generator ; and Mr. Snell showed, by his first sentence, that he laboured under the same idea that the motor must be evolved out of the dynamo. The general mind, even of professional electrical engineers, had been so fascinated by the reversibility of the dynamo, that it seems the electric motor cannot be considered, except as a converted dynamo.

This idea has been propagated and fostered in various ways. In his introductory remarks, when lecturing on storage batteries at the Society of Arts in December, 1881, Prof. Silvanus Thompson stated :

"Not many months before he was seized with the mortal illness, which robbed us too soon of his rare and unique genius, Prof. Clerk Maxwell was asked by a distinguished living man of science what was the greatest scientific discovery of the last 25 years. His reply was : 'That the Gramme machine is reversible.'"

I expressed my doubt upon this statement in a letter to "Knowledge" (December 9th, 1881, page 113), venturing to assert that it could scarcely have escaped so keen-sighted a mind as Clerk Maxwell's that this reversibility followed as a sequence from Lenz's law of Magneto-Electric Induction, as stated by Clerk Maxwell himself in his "Electricity and Magnetism," 2nd edition (section 530, vol. II., page 167) in the following words :

"In all cases the direction of the secondary current is such, that the mechanical action between the conductors is *opposite to the direction of motion*, being a repulsion when the wires are approaching, and an attraction when they are receding. This very important fact was established by Lenz" (Pogg. Annalen, XXI. 438, 1834).

It deserves mention here that this was practically illustrated by Stöhrer in Dresden, who used one and the same magneto-electric machine as a generator and a motor, as long ago as 1851. (See Müller's "Lehrbuch der Physik," 4th edition, 1852 ; vol. II., pages 274 to 277 for the motor, and pages 360 and 361 for the generator.)

It is, however, an acknowledged fact that not every good generator is a good motor, and every good motor makes a good generator. Mr. Snell, in his paper, fully supports this view, and points out that "the cause of this difference between dynamo and motor is to be found in the mutual effects of armature and field."

I beg to submit that we must go back to first principles to find the true cause of this difference, when we shall find that, however reversible the principle of magneto-electric induction may be, we must not employ this principle as a foundation upon which to design and construct electric motors.

In illustration, we might take examples from other branches of engineering, say the compression and expansion of air, where we have to notice the great difference in the design of air compressors and (hot) air motors, or the lifting and falling of water, where we observe the distinction between the water pump and the turbine (or even the nearer allied water engine). So I venture to declare that we must base our design of motors upon a principle different from that employed for dynamos.

In the dynamo we produce an electric current by moving a conductor through a magnetic field ; we cause the conductor to cut lines of magnetic force. This is the broad principle, which applies to all magneto-electric generators. In this case *the production of a magnetic field is our starting point*, and upon this depends the effect we wish to produce. For this reason we must have a *strong* field, since we must guard against its being weakened by the reaction of the armature ;

and this weakening of the field means an inefficient generator.

In a motor we endeavour to obtain mechanical motion by the contraction—the shortening of the lines of magnetic force. We can obtain motion by the mere attraction of a fixed (field) magnet; but, of course, very limited; to produce continuous motion we must employ an electro-magnet, in which the magnetic polarity constantly changes. Here, then, *we start with a rotating electro-magnet*—professionally, but most illogically (I might say ludicrously) termed "armature." With this rotating electro-magnet—say, in the form of a Gramme ring—we can produce motion by placing two iron masses in such a position in relation to the magnetic poles of the electro-magnet as to give the lines of magnetic force a tangential direction, thereby, through the contraction of these lines of force, causing the electro-magnet to rotate *without a field magnet* (in this case another illogical term). Here, then, theory points to a strong rotating magnet (or, in scientific (?) language, "armature"), as the starting point for an efficient motor. In this view I am supported by Profs. Ayrton and Perry, in their paper referred to above.

The future will show how far the views advanced here will be embodied in the practical development of the electric motor; whether the "'exponents of the reversible theory' and its corollary, 'the better the dynamo the better the motor,'" backed by such authorities as Dr. Hopkinson, Prof. Thompson, Mr. Kapp or Mr. Mordey; or whether Profs. Ayrton and Perry with $\frac{2}{10}$-inch "armature" and $\frac{1}{10}$-inch "field-magnet;" or whether the adoption of an intermediate proportion, with a considerable preponderance to be given to the armature (rotating magnet) over the field (fixed) magnet, will be accepted as a guide by the future electrical engineer in the design of electric motors.

But what I make bold enough to declare in relation to the treatment which the subject of electric motors receives at the hands of even those to whom we look upon as authorities on this question is that the attempted identification of the motor and the dynamo by the mere reversal of a principle, and even the comparison of the two as regards their respective efficiency *is waste of energy*, and will not advance the development of the motor towards that important position in electrical industry which it will no doubt assume.

Mr. Snell's paper contains many practical and suggestive remarks which, if dwelt upon, would lead to further discussion; but, with your permission, I will conclude with one citation, which, although again coupling the dynamo with the motor, still supports the views I have expressed. He says in reference to the influence of armature and field magnets:—

"In the second" (suggested) "experiment the armature is large compared with the field. Hence the lead as a dynamo will be great—probably 30 degrees at least in a positive direction; as a motor the lead, if any at all, will be much less—perhaps 5 degrees in the negative direction. The machine will be inefficient as a dynamo, and requires a high speed; but as a motor it will be much more efficient, though the speed will not be so great as that required for the dynamo. The second machine will be a good motor, efficient, light, and cheap. . . . This explanation is very rough, but it will help to explain the reason for *considering the armature as an independent magnet in motor design*."

The importance of the subject is my apology for this long letter, and undoubtedly the great field for the employment of electric motors in the near future will make it most desirable that the subject of motor design should receive our full attention, not only as regards the proportion of rotating to fixed magnets, but also, *and especially so, the mechanical arrangement of these interacting parts;* besides the disposition of iron and copper for avoiding Foucault's currents, reducing mutual induction, avoiding over-heating, &c. As time advances each of these subjects will be sufficient to offer a subject for a paper and an evening's discussion.

C. G. G.

February 5th, 1889.

Red Wires v. Black.

In reference to the letter of Messrs. Drake & Gorham, Red Wires *v.* Black, I can substantiate their statement. For indoor work at Leamington red and black mains and leads were used, and in all cases I found in the red (to use Messrs. Drake and Gorham's words) a marked inferiority both in insulation and durability.

Hy. Albert.

February 4th, 1889.

The Insulation Resistance of Electric Lighting Installations.

Your correspondent, under the signature "Despondent," describes in a clever and sarcastic vein the paper and discussion on "Insulation Resistance" as being "very poor," but one will conclude from the tone of his letter that *his* "Resistance to Isolation" from his tobacco and fireside must be very great.

The discussion took the direction of "suitable materials," but I would point out that the best materials are valueless unless *erected* properly, and to careful erection more attention might advantageously be given. As an example, when wires have been carefully put into wood casing, and are everywhere out of direct contact with brick or plaster walls (that so often become damp), if it is desired to take off a branch the usual practice permits that the branch wire which has to cross over the main may be taken at the *back* of casing, where it is jammed up against the wall, entering the branch casing when outside the main casing: this certainly makes a "neat job," but at this point there is only one-eighth of an inch of wood (the thickness of the casing measured from the bottom of the groove) between the main and branch of opposite sign, and the branch wire directly exposed to the damp; everywhere else great care is taken to maintain the wires in the grooves about an inch apart.

Another "leakage point" is caused by switches being fixed without a back block, the wires on coming out of the casing being jammed by the switch base directly on to the plaster; in badly designed switches the metal work may even touch the plaster.

In fixing ceiling roses the same thing occurs. An installation erected on these lines may be likened to a strong *iron* chain with a *string* loop in it, the chain being just the strength of the string.

I enclose a sample of a block that I have designed and protected, by which the branch wire difficulty is avoided and erection facilitated.

Trusting that I have not encroached too much upon your valuable space,

Fred. Bathurst.

February 5th, 1889.

In common with many others, I regret very much the new arrangements, whereby you are debarred from giving your readers the excellent reports, not only of papers read, but also of the discussion upon these before the Institution of Electrical Engineers. Only for this innovation we would have had a full report of this discussion before us. Now if anything were required to bring home to us the great loss we have sustained, it is assuredly supplied by the perusal of such a lamentation as we have from your *despondent* correspondent. Not having the full report of the discussion we are unable to tender him that sympathy which (his insulation having quite broken down) he desires, but we are sure you have made ample amends, and in your leading article we note your attempt to "Chatterton up" this desperate case; we trust your efforts have been successful; the current of his thoughts have become "continuous, and have an electromotive force of 200 volts, or under."

Your correspondent evidently was inveigled to attend the I. E. E. under false pretences; he no doubt went there hoping to learn something about the best materials for purposes of insulation, &c. (why he should have expected this he knows best), and hearing nothing about this matter his wrath is not to be wondered at; yet, had he taken the slightest trouble to inform himself, he would have seen that the paper was to be on the INSULATION RESISTANCE of Electric Lighting Installations, and he might therefore have remained by his own fireside and smoked the pipe of peace.

The paper by Prof. Jamieson was evidently intended to show what the insulation of such work should and *could* be, and how best (in his opinion) insulation tests should be carried out, and so far it covered the ground fairly well, and if only it would lead up to a settlement of the vexed question, of what is? and what is not sufficient insulation? then the paper will have done good work.

Your *despondent* one rejoices that he is not as one of us, and we heartily rejoice with him, as his whole efforts appear to be an attempt to throw a wet blanket upon every young member of the Institute who attempted to take part in a discussion which he did nothing to redeem. He objects to the use of a portable machine for testing purposes and would prefer a battery. Now will he tell us where such a battery, always ready and to be depended upon, can be got? To compare with the machine it must be capable of giving not less than 50 volts, must have no sloppy liquids to spill or splash about, and such as one man can easily handle. There is no difficulty in supplying such a portable machine, even to give 1,000 volts if need be; this would be always ready for work and require only a fraction of the attention any battery would require. His "budding Faraday" was quite right about the want of elasticity in much of the material supplied as vulcanised rubber, and the gentleman who gave the sensible speech must have concluded that the "budding Faraday" had more green than grey in his eye when he did not expect him to know the difference between the outside tape and the inside rubber. There is nothing remarkable about the great difference in insulation resistance when taken in fine and in damp weather, nor is it to be wondered at that after the installation begins regular work the installation should improve; this is certainly always the case in new buildings, and has become much more noticeable since the fire offices have insisted upon so much slate being used in switches, cut-outs, &c., owing to the way that slate absorbs moisture and in many cases thus lowers the insulation enormously, unless we saturate it with paraffin wax, which we may be told increases the fire risks. It is to be hoped that the prominence you have given this subject in your leader will assist in the settlement of a standard of insulation resistance. Many are sure to regret the tone of your remarks, as the ELECTRICAL REVIEW has always been looked upon as an advocate of thorough and definite tests in all matters electrical and that rule of thumb received no support in your pages. When you suggest the Admiralty test for dynamos it might have occurred to you that this test would be more searching if taken in the dark, as a faint spark would then have been more easily seen. We think an old test of Cromwell Varley's for submarine cables an improvement upon this, and give it, with your permission. "Take a wire from dynamo brush or terminal, another wire from frame of dynamo (to be tested), let the tester insert both wires in his mouth and with a little practice he could easily measure quite near enough the insulation resistance of any dynamo." [N.B.—When testing dynamos of 1,000 volts and upwards, it might be necessary to keep a stock of testers, but this would be merely a detail which could easily be arranged for.] As you recommend that the insulation of dynamos may safely be left to the makers, why not go further, and leave the insulation of the whole installation to the contractors. This would get rid of the Phœnix and all other rules, in fact, seeing that the fire offices leave so much to the discretion of their inspecting officers (who can often "rejoice that they are not as one of us"), the public, we are sure, would not loose by such an arrangement.

The want of consistency throughout your leader is very suggestive; you imply:—

1. That electromotive force has nothing to do with the insulation; immediately you say,
2. It has everything to do with it.
3. That current won't be governed by the rules laid down for its guidance.
4. That the current ought to be so governed.

We never heard until now of the use of Chatterton for I.R. joints, and think its use must be confined to some of our electrical engineers (Heaven save the mark) who would not solder any joints, as the solder would interfere with surface conduction!!!

Are you not in error when you say that one of the objections by the author of the paper was that the Phœnix rule did not take account of candle-power? In his objection, No. 4, it is quite clear that he refers not to the C.P. but to the current, and we believe it to be common knowledge that a 500 C.P. lamp would require more current than a 5 C.P. one, yet the Phœnix rules make no distinction, and each of these would count as one lamp. This, no doubt, would be a case for the discretion of their inspectors. With the last paragraph of your leader the writer is in perfect accord, and hopes that you will not allow this matter to rest until something is agreed upon by all concerned. Why not accept the I.E.E. rules, and if need be raise their standard? The sooner the matter is agreed upon, the more readily will the best rule be taken up and acted upon. Surely such questions are exactly what the I.E.E. should manfully tackle and settle by public discussion amongst its members.

One of These.

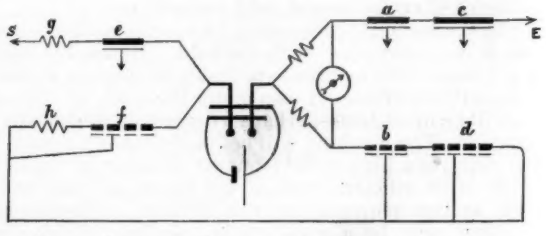
Jacob's Improved Duplex.

With regard to the Note on the above subject in your issue of January 4th, mention is made of an artificial electrical reproduction being used to balance the earth cable. Might I ask, How can this be necessary, seeing that the earth cable is not included in the Bridge system? A word of further explanation would greatly oblige.

E. Raymond-Barker.

Madeira.

P.S.—I venture to enclose a theoretical diagram of Mr. Jacob's arrangement, excluding C *f*, R *g*, R *f*, about which there is no discussion. Does not this diagram



(which I submit to you to publish or not, as you may deem fit) suggest at a glance the non-necessity of balancing the earth connection whether with regard to capacity or resistance?

- *a* = underground cable connecting Dx. apparatus to cable at cable house.
- *b* = electrical reproduction of *a*.
- *c* = submarine cable.
- *d* = electrical reproduction of *c*.
- *e* = underground cable connecting earth terminals of Dx. apparatus to cable sheathing, S, at cable house.
- *f* = electrical reproduction of *e*.
- *g* = resistance of ground connection.
- *h* = electrical reproduction of *g*.
- E = earth a distant station.